THE PROGRESSIVE FISH CULTURIST

NEWS AND VIEWS FROM MANY SOURCES ON PRACTICAL HATCHERY PROBLEMS

ISSUED BY THE

U. S. DEPARTMENT OF COMMERCE
DANIEL C. ROPER, SECRETARY

BUREAU OF FISHERIES
FRANK T. BELL, COMMISSIONER

JUNE-JULY 1938

WASHINGTON

TABLE OF CONTENTS

	Page
TREAT - THINK - and be Wary for Tomorrow They May Die; Some advice on the prevention and treatment of fish diseases, by Frederic F. Fish	1
SOLDERING and Sheet-metal Work for Hatcheries, by Nathan B. Fruchter	9
EFFECT of Amount of Food on Fin Condition of Fingerling Trout, by Louis E. Wolf	16
WISCONSIN Lakes and Fish Investigations, by Chancey Juday	18
A VISIT to Paradise, by Cecil Heacox	21
COMMENTS from our Readers:	
Reactions to Mr. Young's challenge: "Where Do We Go From Here?", by Frank H. Connell, William M. Keil, H. S. Davis,	24
Again, Fish Sorters, by Louis E. Wolf	28
NOTES and News:	
Second Annual Meeting of Northeastern Fish Culturists	31
Annual Meeting of the Pacific Fishery Biologists	34
Notice to Contributors	43
REVIEWS:	
Nesbit, Robert A. and J. Arthur Kitson: Some Results of Trout Tagging in Massachusetts, by R. L. Carson	44
Ellis, M. M., H. L. Motley, M. D. Ellis, and R. O. Jones: Selenium Poisoning in Fishes, by R. L. Carson	46
Lagler, Karl F.: Fish Predation Investigation, by R. L. Carson	47
Otterstrom, C. V.: Farming Danish Trout for Export, by Ralph Hile	48

THE PROGRESSIVE FISH CULTURIST

A SERIAL memorandum published occasionally for the advancement of Federal, State, and private fish culture and fishery management in fresh waters.

Editor

Elmer Higgins, Chief, Division of Scientific Inquiry, U. S. Bureau of Fisheries.

Associate Editors

Dr. H. S. Davis, In Charge, Aquicultural Investigations, U. S. Bureau of Fisheries.
Professor Lauren R. Donaldson, School of Fisheries, University of Washington.
Dr. A. S. Hazzard, Institute for Fisheries Research, Michigan Conservation Department.
M. C. James, Assistant Chief, Division of Fish Culture, U. S. Bureau of Fisheries.
Dr. A. H. Wiebe, Biological Readjustment Unit, Tennessee Valley Authority.
Dr. Louis E. Wolf, New York Department of Conservation.

APPLICATIONS for this memo, which is distributed free on regular mailing lists, should be addressed to the Commissioner of Fisheries, Washington, D. C. Contributions for publication are welcome.

While a certain amount of editorial selection of material is exercised, the U. S. BUREAU OF FISHERIES DOES NOT NECESSARILY ENDORSE AND IS NOT RESPONSIBLE for the statements of facts nor for views and opinions published herein.

9874

THE PROGRESSIVE FISH CULTURIST

NEWS AND VIEWS FROM MANY SOURCES ON PRACTICAL HATCHERY PROBLEMS

ISSUED BY THE

BUREAU OF FISHERIES, U. S. DEPARTMENT OF COMMERCE

Memorandum I-131 Washington, D. C., June-July, 1938 No. 39.

TREAT - THINK - AND BE WARY, FOR TOMORROW THEY MAY DIE

SOME ADVICE ON THE PREVENTION AND TREATMENT OF FISH DISEASES

By Frederic F. Fish

U. S. Bureau of Fisheries, Seattle, Washington

FOR SOME very strange reason it is easy to minimize the villain's role, played by disease-producing organisms, in the theater of modern fish culture. Much concern is felt over the food bills footed each month by the hatcheries, but very little is thought about the dead fish which are picked from the hatchery troughs during the same period.

Perhaps for our general peace of mind it is just as well that we do not know all that we might about the cost of dead hatchery fish, but from the little we do know, it appears that every time the hatcheryman hands a one-dollar bill to the food man out the front door, the Grim Reaper makes out the back door with fish worth a dollar and a half. Add up the combined hatchery food bills in the United States and you will reach an impressive sum. Add up the annual bills for dead fish and you will undoubtedly reach the conclusion that it is high time we stopped pussyfooting about diseases and took a little more interest in them.

The food bill is plenty high but it is comforting to see the food cost per-pound-of-fish-produced slowly coming down in response to the unceasing attacks upon the problem through patient research and the immediate application of laboratory findings in the hatcheries. Can the same be said for the rising costs of dead fish? In answer to that question, I shall merely quote Dr. W. Rushton, eminent English biologist and ichthyologist, who, in reminiscence of his visit to the United States in 1936, wrote: "The work on nutrition being carried out at some of the hatcheries

and the selective breeding and rearing was exceptionally fine and pleased me beyond measure, but the amount of work being carried out on disease and the conditions causing it was not developed to the extent one expected...."

There are two reasons why our bill for dead fish is so high. In the first place, for years losses among hatchery fish were not considered of sufficient importance to warrant consideration or investigation. Unlike the food bill which is stated in dollars and cents, the dead fish bill is stated, primarily, in terms of wasted effort and wasted resources which must be translated into monetary figures. This translation is seldom attempted, thanks to a peculiar psychology concerning losses which developed during the adolescence of fish culture. In its infancy, artificial propagation was sold to the general public on the premise that "an egg in the hatchery is an egg saved". This wish eventually became father to the thought and it was carried along through dubious accounting methods justified by the fervent hope that the hatcheries, losses or no losses, were still more efficient than Nature. As long as this attitude prevailed, there seemed little point in devoting attention to such an abstract subject as diseases and their effect upon hatchery production.

The second reason for the high dead fish bill is that, although the importance of hatchery losses is now being recognized, still too few hatcherymen find the time or inclination to apply the little knowledge we now possess to their own problems. Most fish culturists will do everything in their power to check an epidemic once it develops in their hatchery, but few connect such trouble with some possibly preventable occurrence which took place several weeks before the epidemic appeared.

As this article is intended to be informative and not a wailing stone, there seems little point in dwelling further on the first reason for the high price we pay for dead fish as that condition is slowly curing itself. The second point, however, will bear considerable expansion.

The hatchery disease problem falls, essentially, into two categories: Disease prevention and disease control. Of these disease prevention is of greater importance at the moment for it is herein that knowledge has far outstripped its application. These two categories are b st discussed separately although they are in no small way interrelated.

I. DISEASE PREVENTION

Water supply and equipment.

The prevention of disease starts with the location and equipment of the new hatchery. No hatchery should be dependent upon an unfiltered water supply, although unfortunately, Nature's great source of filtered water, the spring, is not always available and some compromise must be made. However, it must be remembered that compromises in fish culture invariably lead to lowered efficiency. Regardless of the source, the water for a hatchery should be chemically and bacteriologically pure, high in dissolved oxygen, and without extreme daily or annual fluctuations in temperature. Needless to say, all wild fish should be removed from the water supply, if a spring is used, before the hatchery is under production for it may be practically impossible to remove them afterwards. As for equipment, not more than two troughs should ever be used in series and, preferably, each trough should be independently

supplied and drained. While such an arrangement may reduce the capacity of a hatchery, nevertheless it is far better to start with fewer fish and bring them all through in a healthy condition than to stack in the eggs and take losses from overcrowding. Hatchery capacity should be judged by the number of healthy fish produced and not by the total number of eggs which can be carried in the troughs. Ponds, at least for fingerling fish, should be small enough and suitably designed so that they may be kept absolutely clean at all times. The shallower the pond, the more rapid the replacement and therefore the purer the water. Cleanliness is not next to godliness at a fish hatchery; it supersedes it.

Inter-hatchery exchange.

Once the hatchery is under production, much can be done to avoid disease, the major approaches being to prevent the spread of disease from one hatchery to another and from place to place in the same hatchery. Every hatchery should be an independent unit, raising eggs taken from their own brood stock and thus avoiding all importation of alien stock. While this is true of many of the hatcheries in the East, it is decidedly the exception in the West. Under such conditions wherein the hatcheries cannot be independent units, it should be, but definitely is not, a hard and fast fish cultural law that under no circumstances should fish ever be transferred from one hatchery to another except as eggs. This law should further provide that all eggs must be sterilized before shipment, carried only on sterilized trays in sterilized cases and cushioned with sterilized moss. Eggs are easily sterilized without injury by immersion in a 1 to 2,000 solution of neutral acriflavine for 25 minutes. Egg trays and moss may be sterilized in boiling water for one minute, never by the use of chemicals. Egg cases may be thoroughly dried, preferably in sunshine, for at least eight hours before use. All of these methods have been known for several years but are seldom applied.

Spread of disease within the hatchery.

Preventing diseases from spreading within a hatchery consists, essentially, in preventing the spread of water from one trough to another for in so far as is known all disease of fish are water-borne. This may seem quite elementary, but it is amazing how many times in a day water is carried from one trough to another on brushes, food dippers, nets, or even on the attendant's hands. It is done so often that it becomes involuntary which means that it is a very difficult habit to stop. Avoiding the transfer of water, possibly carrying disease-producing organisms, from one trough or pond to another involves keeping the hands dry. When this is impossible, the hands should be thoroughly dried before moving on to the next trough. It involves feeding the fish from above, allowing the food to fall upon the surface of the water rather than washing it off a spoon or through a dipper. Fish should be attended in reverse order to the size, the smallest ones first, and yearling and adult fish should be left alone as much as possible. Last, but of great importance, the habit of sterilizing every brush, net, or other utensil used in the troughs just as soon as it is taken from the trough must be acquired to the point wherein such action becomes second nature.

It is not at all difficult to keep these utensils in a 1 to 100,000 solution of some powerful disinfectant, such as H.T.H.-65, from which they may be taken when needed and to which they are returned. Likewise, whenever fish are removed from a pond or trough, regardless of their past history, that pond or trough should be sterilized before it is again used. Sterilization of a pond or trough is most simple; merely fill it slightly above the normal water level, plug the drain and inflow, and add sufficient H.T.H.-65 to make a 1 to 100,000 solution (one ounce of the powder to every 740 gallons of water to be sterilized). This solution should be left in the trough over night and be thoroughly flushed out the following morning. A four pound can of H.T.H.-65 costs in the neighborhood of a dollar and a half and will make slightly more than 50,000 gallons of a 1 to 100,000 solution.

While the general adoption in the hatcheries of what the bacteriologists call "sterile technique" may appear to be an unnecessary luxury, it is the basic requirement for preventing disease. Sterile technique, an uncontaminated water supply, and the absolute prohibition of alien stock together comprise the basic requirements for an efficient hatchery wherein contagious diseases are unknown. It is quite true that few, if any, hatcheries possess and practice these requirements. However, as food for thought, it is likewise true that fish culture today is the most backward branch of animal husbandry. In the interest of efficiency, eventually fish culture will be driven to the universal adoption of these fundamentals and the longer their adoption is deferred, the longer disease will continue to be the greatest limiting factor to the success of artificial propagation.

II. DISEASE CONTROL

Difficulties of treatment.

The second part of this story concerns the control of diseases once they have appeared in the hatchery. Surprisingly enough, in spite of the fact that disease control measures have become almost an every day occurrence at most hatcheries, actually very little is known about their exact effect. These control measures, for the most part, consist in various methods for immersing ailing fish in a disinfecting solution following the theory that the solution will kill the troublesome bugs before it will kill the fish. This theory is decidedly open to question and there is little doubt that in many instances the solutions used may or may not have killed the bugs but they certainly did kill the fish. One of the reasons for this unfortunate and very expensive occurrence is the fact that pathologists have been woefully negligent in evaluating treatments before recommending them to the hatcherymen. Pathologists, likewise, have been negligent in warning hatcherymen that treatments are decidedly not such innocuous affairs as the directions given would indicate.

Everyone concerned with the artificial propagation of fish is well acquainted with the familiar directions to "dip all ailing fish in a 1 to 2,000 solution of copper sulphate for approximately two minutes". Such a recommendation should be applied with a prayer for in following these directions, the dip may be of very limited value at a hard-water hatchery where much of the copper (which is the disinfecting ingredient) immediately combines with the carbonates present in the water to form an insoluble, and therefore ineffective compound. Again, if these directions are followed explicitly at a soft-water station, such as are found in the far West,

the dip will kill healthy fish, let alone those weakened by disease. Yet in spite of this, all the directions for the use of copper sulphate in dips completely ignore this wide discrepancy in its effect or refer to it in a very vague manner. Obviously, it would be impossible to predetermine the exact effect of copper sulphate under the particular water conditions to be found at every hatchery in the United States. However, it is not impossible to warn fish culturists that any treatment whatever is a physical ordeal for the fish even when applied with the utmost care. The failure to impress this fact upon the hatcherymen has resulted in a universal impression that any form of treatment can do no harm and might do some good regardless of the method of administration. Under the circumstances, this is an unhealthy state of mind and no doubt has sacrificed more fish in the past than treatments have ever saved.

All treatments, with the possible exception of salting, at best represent an exceedingly close race between killing the parasite and killing the fish and the margin between these effects is entirely too narrow to justify the custom of weighing out disinfectants by the handful instead of by the gram and in timing the bath with the physiological stopwatch of knocked-out fish. The man in the hatchery must beware of all methods of treatment recommended to him although this does not imply that he should merely sit back on his haunches and do nothing about a new method, or an old one either for that matter. Every method recommended by a reliable laboratory has undoubtedly been found effective under a certain set of conditions and it is up to the hatcheryman to work out the application of this method to conditions found at his own establishment before the need for treatment arises. Working with small experimental lots of healthy fish, he should apply the recommended treatment with the utmost care, varying the concentration of disinfectant and the duration of exposure until he finds the proper dose which can be administered without harm to fish at his own hatchery. Each fish culturist must work out his own salvation at his particular hatchery; the laboratory findings are merely a base from which to deviate in finding an effective, yet non-toxic, application.

Methods of treatment.

Regardless of the concentration of disinfectants used, the technique of application influences the success of any treatment to no small degree. It might, therefore, be advantageous to briefly outline the various methods of treatment in common use and the recommended technique for their application.

Aside from medicines administered with the food, treatments may be roughly divided into four basic methods: (1) salting; (2) flushing; (3) hand dipping; and (4) prolonged treatments.

Salting.

Salting is an ideal trough treatment except for the one limitation that it will not cure everything. In troughs, it is extremely simple to apply; it is reasonably effective against the external protozoan parasites; it is an excellent tonic to the fish; and its application demands the least accuracy of any known form of treatment.

There are many ways to salt fish, some good and others definitely bad. My own choice, which I think as good as any and superior to most, is to determine the volume of water contained in a trough drawn down to a predetermined depth, say two incnes. By multiplying the inside length of the trough by tne inside width and the product of these two numbers by the predetermined depth, all expressed in inches, one obtains the water content in cubic inches. For each 150 cubic inches of water in the trough at this predetermined depth, one ounce of finely ground salt is dissolved in a pail half full of water. To administer the salting, shut off the inflowing water, drain tne trough to the predetermined depth, and spread tne salt solution from tne pail evenly over the trough.

Fingerling trout will withstand this concentration for six to ten minutes. When several of tne weaker fish have turned over, the inflow is resumed at tne maximum rate whicn tne fish will withstand and tne drain partially opened to permit a rapid replacement of the salt water. This method may be applied to fish as often as desired witnout apparent injury and, indeed, with a definitely tonic effect. When repeated three times at 24 hour intervals, salting is quite effective in curbing epidemics caused by external protozoans and it is tne only treatment which should ever be applied in the absence of definite knowledge regarding the cause of any mortality. Salting, however, becomes progressively more expensive, less effective, and more difficult to apply as the size of the body of water to be treated increases.

Flushing.

Regarding the second method, namely flusning, which is used primarily as a preventive, very little is known - far too little to justify much comment. The method consists in routinely adding several fluid ounces of a disinfectant solution of definite strength to the upper end of a trough and allowing it to flow down the trough and out. This method may have distinct possibilities. At least as now usually applied it does not appear to be toxic to the fish. However, in my own experience at least, on the only occasion which has come to my attention this method of applying copper sulphate solution definitely did not prevent an epidemic of Gyrodactylus. unquestionably, this method should be further investigated under controlled conditions.

Dipping.

The third basic method, hand dipping, could be the subject of several closely written volumes. Suffice it to say that this method is a dangerous one for the solutions used are powerful and relatively concentrated, hence the difference between an effective dose and a killing one is exceedingly narrow in view of our present lack of knowledge concerning this very common method of treatment. When applied with extreme care, it undoubtedly may be of great value in controlling epidemics of external parasites and certain types of bacterial diseases such as fin rot, ulcer disease, and the eastern type of gill disease. However, the way hand dipping is often administered undoubtedly does more harm than good. The belief is generally prevalent that hand dipping expectedly is accompanied by an excessively high mortality. Many times, if one takes the trouble to analyze the daily mortalities, the dipping incurred a greater mortality in a single day than the disease being treated would have

claimed in a period of two weeks. The inevitable reply to this fact is a knowing estimate of the astronomical numbers of fish which the disease would have taken had not treatment, disastrous as it was, been given. The answer is problematic no doubt, but if a hatcheryman will sometime leave a typical trough of fish untreated as a control to indicate what would have happened in the absence of all treatment, he will have an extremely valuable check upon his technique of dipping and a possible insight into that usually overlooked phenomenon called natural recovery. Certainly hand dipping should never be applied to any large number of fish unless there is valid reason to believe that some external parasite is causing the losses. In the absence of such reason, a dip should be applied to a small number of fish as an experiment. If the percentage loss on this isolated group does not fall significantly below that of the entire group of affected fish within two days after the experimental treatment was administered, that method of treatment should be foregone.

As for the exact technique of hand dipping, in my opinion it is best done in a dipping box. This apparatus fundamentally consists of a solidly constructed, watertight, wooden box, in cross section about two inches narrower than the hatchery troughs, about half again as deep, and approximately three feet long. The box is legibly marked at the height attained by a known volume of water. In this dipping box is slung an inner compartment, resting on four "ears" which are sufficiently wide to rest on the top of the dipping box, yet sufficiently narrow to slip into the hatcery troughs. This inner compartment is made from two wooden sides, rounded vertically at the ends and the bottom is covered with a coarse mesh galvanized wire screening. The galvanized mesh, in turn, is covered with bobbinet on the inside, the bobbinet being caught to the wire mesh at a sufficient number of points to keep the bobbinet from floating off.

In use, the desired quantity of disinfectant is weighed out and dissolved in the box filled to the calibration mark. The inner compartment is then placed in the trough containing the fish to be treated where a convenient number of fish may be placed in it from the trough by means of a scaff net. The compartment is then removed to the dipping box and the fish immersed in the disinfectant. After the required time for the dip has elapsed, the inner compartment is carefully lifted from the dipping box and immersed in the trough to contain the treated fish. By slowly lifting the "upstream" end, the fish slip out of the "downstream" end. The solution in the dipping box should be aerated constantly and renewed frequently. Needless to say, the temperature differences between the infected trough, the dipping box, and the treated trough should at no time exceed 5°F.

Prolonged treatment.

The fourth method of treatment, namely prolonged treatment, is based upon the theory that a long exposure to a dilute solution of disinfectant is more efficacious and less toxic than is the short, concentrated hand dip. Furthermore, it may be applied without handling the fish, a factor which is not serious if the fish are carefully treated from troughs but may become very much so when the fish are in ponds where a seine must be used and a large number of fish are involved. Prolonged treatment of fish, either in ponds or troughs, does obviate this very objectionable feature

Unfortunately, prolonged treatments must still be regarded as in the experimental stage and while they are, theoretically, far superior to hand dips, we have much to learn concerning their practical application.

Prolonged treatment originally consisted of adding to the inflowing water by means of some convenient apparatus, sufficient dissolved disinfectant at a uniform rate to maintain a constant concentration of disinfectant over a definite period of time, usually one hour. This method of treating the inflowing water is subject to an inherent inaccuracy due to the diluting influence of the residual water in the pond at the time treatment is started. This inaccuracy is not serious in the case of troughs or small raceways which may be drained practically to dryness and which fill rapidly, but it becomes progressively more so as the size of the body of water to be treated is increased. For the treatment of the larger types of fish cultural equipment such as circular pools and raceways, the most recent development is prolonged treatments is essentially identical to the method of salting described above except that the disinfectant-concentration used is much weaker so that the fish may be safely exposed for a period of several hours during which time, the water is recirculated in a closed system from the lower end of the pond to the upper by means of a centrifugal pump. This assures adequate aeration during the time when the inflowing water is stopped.

When to treat.

In any method of treatment, time is of vital importance. Disease rapidly lowers the vitality of small fish and although today they may withstand the rigors of treatment, tomorrow may find them too weak. The fish culturist must maintain strict watch on his stock. Many external parasites give early warning of their presence which is evidenced by the fish refusing to eat, scratching themselves or assuming a characteristic bluish-grey sheen. Fungus, of course, is an excellent indicator of trouble but it usually does not appear until after the tell-tale rise in the daily losses which are the surest proof that trouble is present.

Immediately upon any suspicion of trouble and always in the event of increasing losses, the fish should be carefully examined for gross lesions and all possible extraordinary factors such as bad food, silt, sudden fluctuations in water temperature, etc., should be checked. If nothing can be found, the fish should be examined for parasites and microscopic lesions. If still no demonstrable source of trouble can be found, a few obviously affected fish should be preserved in a ten per cent solution of formalin and forwarded, with full particulars, to the nearest pathology laboratory. Following this, all fish should be salted. In the early stages of disease when relatively few fish are as yet affected, these should be removed to an isolated "hospital trough" to prevent spread of the disease to the healthy fish. Needless to say, strict quarantine must be employed to keep the disease from spreading through the rest of the hatchery stock.

Such is the story of our bill for dead fish today. The path already taken to lower the food bill must be followed in the case of fish disease by laboratory workers and fish culturists alike. Every step along this path not only lowers the cost of production but also puts more fish in the streams which, after all, is the fundamental purpose of artificial propagation.

SOLDERING AND SHEET-METAL WORK FOR HATCHERIES

By Nathan B. Fruchter,
U. S. Fisheries Station, Santa Rosa, N. M.

IN THE issue of THE PROGRESSIVE FISH CULTURIST for August of 1937, Mr. Haskell pointed out that the hatchery foreman is concerned with many types of work other than fish propagation, and then proceeded to treat the readers to a valuable discussion on concrete construction. It is because of that article that I am inspired to throw in my bit on soldering and sheet-metal work.

The presence of water just naturally calls for sheet metal and that in turn requires soldering. For a great many hatchery uses, sheet metal is much superior to wood. It is lighter and tougher and being nonporous it is more thoroughly sterilized. Were it not for the mystery surrounding the calling of sheet-metal work and soldering, perhaps more of it would be employed to the general improvement of many pieces of hatchery equipment.

In hatcheries where fish food is refrigerated, a great saving in space can be realized through the use of square containers. Moreover, they can be built to fit the particular unit, and if well made, should outlast several pails. Food preparation rooms and counters especially can be made to look more attractive and offer greater convenience through the use of sheet metal. A drawer under the meat bench or grinder with a wire mesh bottom will permit the draining and drying of knives, cutters and grinder plates without retaining that objectionable odor of stale meat.

Wetting floors at the head end of troughs can often be prevented through the use of properly designed splash guards. Fish traps, all the way from minnow traps to those designed for catching brood fish, will be more rigid and more safely handled if they are properly soldered together instead of being wire-tied with plenty of sharp points left exposed for finger skinning. The mesh used in making these traps being galvanized makes a soldered job not only desirable but also very simple. If there is one thing that solder will stick to, it is galvanized wire mesh.

Most people are more or less acquainted with the art of soldering, but perhaps a few pointers will not be amiss. Irons are rated according to what a pair of them will weigh. A number 2 iron, for example, will weigh one pound. In general the size of iron to use is best determined by the work required of it. For soldering heavy gauge metal, brass or copper in particular, or fittings made of such metal, an iron weighing two pounds or more will be a necessity; the lighter gauges of metal, and small work in general, will call for one weighing not more than half a pound. However, one weighing about three quarters of a pound to a pound, will probably satisfy most hatchery needs.

A good electric iron is excellent for bench work, but it should be heavy enough for the hundred and one jobs around the hatchery. Here again, the size depends upon the work. An iron of about 125 watts, with a copper tip of 1" in diameter, or at least 2 ounces in weight, should prove most serviceable. Some irons come with interchangeable tips, one light and one heavy. These are quite practical. The possession of an electric iron, however, does not eliminate the need for a plain copper bolt. There is always the job beyond the reach of an extension cord, and most hatcheries find uses for a gasoline torch other than that of heating a soldering iron. A modern gasoline torch is a good investment in itself. One should not expect to pay less than $3.00 nor is it necessary to pay much more than $5.00 for a good serviceable torch, and none but white gasoline should ever be burned in it. The better torch will have the filler plug in the bottom, and the bottom itself will be funnel-shaped. This makes for easier filling, yet prevents over-filling, since some space must remain to build up the air pressure. Where utility gas is available, a gas furnace is the best source of heat for soldering. Any handy man can construct one for next to nothing, or one can be bought for a small outlay.

The soldering copper, as it comes from the factory, is ready to be tinned. For this purpose the tinner's best standby is sal amoniac (ammonium chloride). A cake can be bought at one of the larger hardware stores, mail order houses, or from the nearest tin shop. As the iron is heated, the play of colors is watched until the gold has turned to blue. A good sized drop of solder is melted on the sal ammoniac and each face of the iron is rubbed in the molten solder until it acquires a thorough coating and looks as though it had been nickel plated. The iron is then ready for use. In the course of time and through repeated heating, this coating will be burned off, the point itself becoming rough and ridged. To be retinned, it must be filed or ground bright again and the tinning process repeated. As the point wears off, it is a good policy to reforge the iron to restore it to its original shape even though that will reduce its size. The iron is allowed to become red hot, then hammered out on an anvil, giving the point the same taper it had at the start. While in use, the iron will become coated with carbon and other foreign matter. This should be removed after each heating. Tinners either give it a quick swipe on their overalls, or use a dip made of equal portions of muriatic acid and water. The heat of the iron is best judged by holding it up to the face.

The pieces of metal to be joined should be scraped clean for some distance along each side of the joint. The scraping should be done right down and into the metal. This is very important, for in soldering cleanliness is not only next to godliness, it is godliness itself. That applies to the soldering iron as well as to the surfaces to be soldered. A little more time spent in the cleaning will save time and temper in the soldering. Most soldering failures can be traced to improper cleaning. A little muriatic acid will sometimes be helpful in cleaning rusty metal, but this must be washed off if some flux other than the straight acid is to be used, as it may cause subsequent rusting under the joint. New metal, of course, will require no preparation.

The application of a flux is the next step. This is to prevent the oxidization of the metal under the heat of the iron. Of fluxes, there are a number of different types on the market, both paste and liquid, as well as those contained in the solder itself, and known as acid or rosin core solder. Paste fluxes, while more convenient to handle, and excellent for new tin, are somewhat harder to use on other metals since, containing a greasy base, a hotter iron and more rubbing is required than with a liquid one. Kester and No-korrode are good types of past fluxes. A very convenient flux is put up in powder form by the No-Korrode Company and is called Soldering Salts. It is only necessary to dissolve some in water according to directions, to produce an all purpose flux of excellent properties. Flux-cored solder is quite handy for small jobs, but since the flux cannot be applied independently of the solder, and because of its comparatively higher cost, it is usually frowned upon. Plain solder in wire form is very commendable. Its slightly higher cost is more than offset by the convenience in handling, and economy in use. Where a large amount of solder is used, however, bar solder is still the best bet. The handiest and least expensive flux however, is muriatic acid, or commercial hydrochloric acid, as it is sometimes called. For galvanized iron, it is used as it comes; for all other metals such as copper, brass, zinc, tin, lead, etc., it must be prepared by dissolving in it as much zinc as it will hold. This is termed "killed acid". To do this, the zinc is cut into strips and immersed in the acid. Care should be taken to do this out of doors or in a well ventilated room as the fumes given off are very irritating. The container, too, gets too hot to be held in the hand. It is hardly necessary, to say that the acid should be handled in glass containers.

The flux is applied along the proposed joint, allowing it to flow under the lap. A good sized drop of solder is melted off the bar and onto the joint, and as the two surfaces are pressed together with the bar of solder or other instrument, the iron is worked back and forth to allow the molten solder to flow freely between and under the lap. This is called "sweating" it in. The actual soldering is carried on with one of the faces or edges of the iron in contact with the metal rather than the point itself and the iron is moved parallel to the joint. The pressure is continued after the iron is removed and until the solder changes from bright to dull and back to bright again when it may be released.

When soldering a long joint where the edges are not held together by some form of seaming or riveting, a few spots along the joint should be lightly soldered first. This is called "tacking". The spaces between these spots are then filled in. This is done to prevent the expansion by heat of the edges and the distortion of the joint.

The rule in soldering is a hot iron and in working with brass or copper the iron must be especially hot as these metals are excellent heat conductors and will quickly dissipate the heat to the point where the solder will refuse to flow. However, the inevitable exception to this rule is in patching holes, bridging a gap, or in any building up work. Here the iron should be somewhat cool. This will allow the solder drops to remain where they fall, build up, and bridge the opening. The irregular mass should then be smoothed down with a hot iron, care being taken that the whole mass is not melted at one time. For vertical or overhead soldering, only one face of the iron should be tinned. This will keep the solder from running down to the underside of the iron.

When building up or filling a dent, quite often the difference between an amateur and professional looking job is the addition of a few file strokes. Just enough filing is necessary to make the soldered part merge with the contour lines of the surrounding metal. In connection with filing solder, when the file clogs, it is a simple matter to heat it over an open flame until the solder melts, then quickly brushing it off with a wire brush.

Much of the mystery in laying out sheet-metal work would disappear it if were kept in mind that this work is, after all, just a practical application of the principles learned in plane geometry. Where any doubt exists as to the correct layout, the article should first be designed on stiff brown wrapping paper. What can be done with paper and glue, can be done with sheet metal and solder.

Galvanized iron should never be struck with a metal hammer against a metal anvil. This tends to stretch the metal, to make a bend too sharp, and to flake off the protective zinc coating. A metal hammer on a wooden surface, or better still, a wooden (or rubber) mallet on a metal surface, is preferable.

To produce a good looking bend, the metal should be formed over some sharp metallic edge. Where the portion to be bent over is wide enough, it should first be bent over by hand. Then, while moving a weight along the top, the bend is made sharp by striking along the side close to the weight (see figure 1.). Where only a narrow edge is to be bent over, the mallet strokes should be light and even, otherwise the metal will be stretched and produce a curved edge on the bend. Another method, where possible, is to fold the metal completely over, hammer the bend lightly and evenly, then bring it back to ninety degrees, or whatever angle the bend is supposed to be.

The most common form of joint is the lock seam. This is made by turning up 1/4" along the edge of one sheet to a right angle. One quarter inch of the other sheet is turned down and folded over flat. This double edge is now given a quarter turn in the opposite direction, and slightly opened with a knife blade or other thin instrument to form a "V". This is inverted over the upright edge, and the sides pinched together to form a standing seam. To finish the lock seam, the standing seem is laid over with a mallet and locked with a groover. Lacking this tool, a dull cold chisel can be run along the crease. A few center punch marks, or solder tacks, will help in making seams more permanent (see figure 2.).

In riveting light metals, no holes are usually punched or drilled. The rivet is set under the desired spot, and a few light hammer blows directly over it will soon show its exact location. A hollow block with the hole somewhat larger than the rivet, (a large nut will do) is driven on the spot, and brings the rivet through the metal for heading over (see figure 3.).

Since thin metal is more easily stretched than compressed, an outside flange is more easily managed than an inside one. In either case, the flange should be as narrow as possible. For an outside flange on round surfaces, the edges may be bent over before the surface is rounded. For an inside flange, however, the surface should

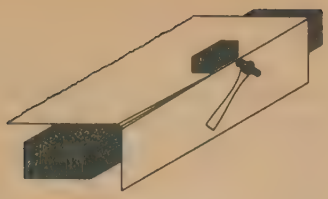

FIG. 1. *MAKING A BEND* SHARP

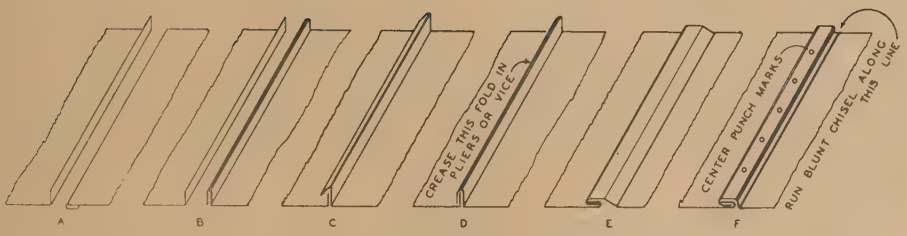

FIG. 2. *THE LOCK SEAM*

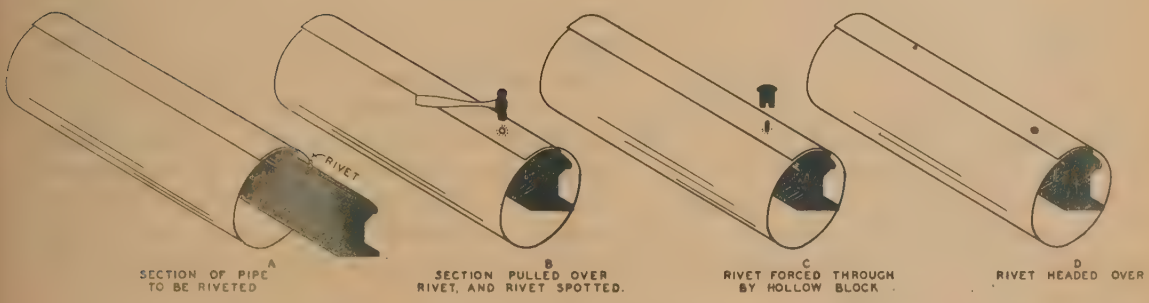

FIG. 3.

FIG 4. *BENDING AN OUTSIDE FLANGE AFTER FORMING CYLINDER*

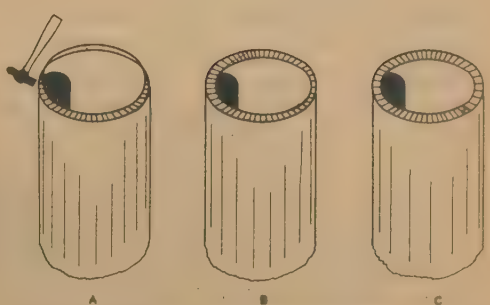

FIG. 5. *BENDING AN INSIDE FLANGE AFTER FORMING CYLINDER*

always be rounded first. An assortment of iron blocks of various shapes and sizes will be found a great help in forming the metal. Particularly should one have some with sharp, straight edges for forming bands in closed shapes (see figures 4 and 5.).

Mention has been made of fish traps. Here is a simple method of making the funnel for those of cylindrical shape. The mesh should be cut in the form of a semi-circle with a radius equal to the diameter of the trap. The semi-circle is folded about its center and the halves of the diameter soldered together forming a cone. Thus, if the trap be 18" in diameter, the semi-circle should be 36" in diameter. The resulting cone will have sides 18" long, will be 18" across the base, and will just fit into the trap. The hole in the funnel is best made by shaping a piece of wire to a ring the size of the required hole. The ring is slipped over the cone and the pointed top is cut off about 1/2" about the ring. The lap thus left is bent back over the ring and soldered. This construction will provide reinforcement, keep the hole from wearing larger, and protect the fish from loose wire ends as they mill about in the trap.

In trout hatcheries where meat must be ground several times over, a great deal of tedious work can be eliminated through the use of a hopper (see figure 6). A tapering sheet-metal sleeve is first made, and forced into the mouth of the grinder till it jams. A little hammering will be necessary to make it assume the shape of the grinder. Enough of the projecting lower edge is trimmed to allow the worm free play. Where the grinder is perfectly round, as in those with fitted trays, no packing shoulder will be required; but those with flaring mouths will need a close fitting shoulder to seal them, and keep the hopper in place. To make this shoulder, the sleeve is tinned at the point where it first makes contact with the grinder. Then, with the sleeve held tightly in place, enough solder is melted from the bar to allow the building up of a shoulder between the sleeve and the grinler wall. The space need not be filled completely to the top. Merely enough is added to provide the hopper with a good solid footing. The mass of solder should be touched up, filed and trimmed to a workmanlike job. If this is done properly, a perfect fit allowing a minimum of leakage will result. The upper part of the sleeve should be trimmed off well above the top of the grinder.

The body of the hopper is easiest made from an old pail whose bottom has rusted out. The funnel-shaped neck connecting the body to the sleeve will require a little care in the making (see figure 7). The circumference of the pail at the bottom is measured, and a straight line A-B of equal length is laid off on a sheet of metal some distance from the edge of the sheet. The length of the funnel is decided upon. This is a matter of choice, but about three quarters the height of the body might be about right. A straight line X-Y of the same length should bisect the first line at right angles at X. The circumference of the sleeve at the top is measured, and a line C-D of equal length should be drawn at right angles to X-Y, centering at Y. The points A C and B D are joined by lines produced to meet at O. With O as centre and radius A C and B D are joined by lines produced to meet at O. With O as centre and radius O A, the arcs A B and C D are drawn. These will be the top and bottom of the funnel. The actual cutting should be done about an inch above and below these arcs, so that the funnel will readily receive the pail top and slip into the sleeve bottom. The joints can be either soldered or seamed, depending on the skill of the craftsman. Soldering would be the easier method, seaming and soldering the more lasting.

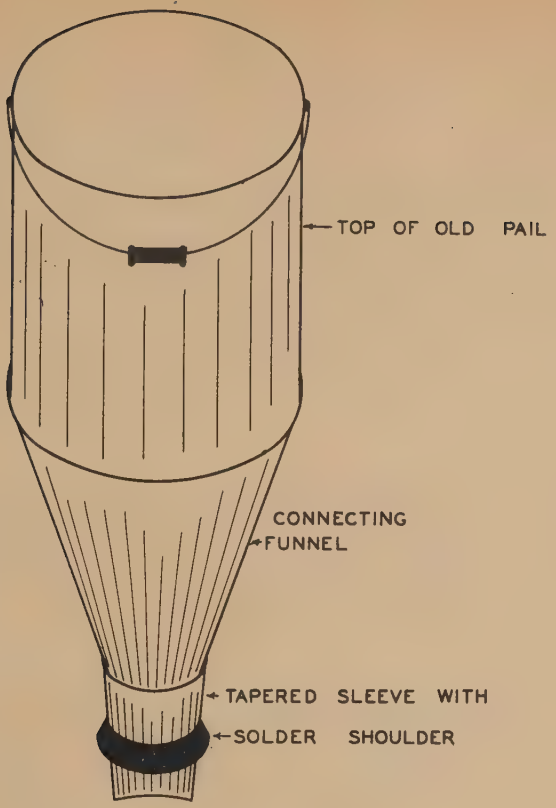

FIG. 6. *MEAT HOPPER*

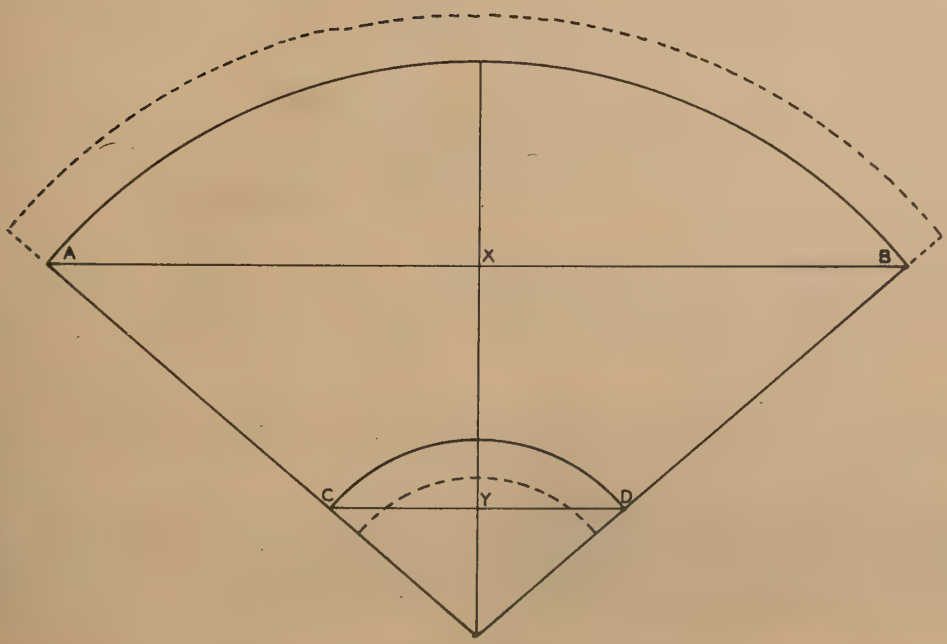

FIG. 7. *DIAGRAM SHOWING METHOD OF LAYING OUT CONNECTING FUNNEL*

Liver will pass through quite readily, but hearts may require a little water to reduce the mixture to the proper consistency for passing. The water will also prevent the meat from sticking to the sides of the hopper. Depending on its size, two or three pails of meat will pass through the hopper without any attention.

EFFECT OF AMOUNT OF FOOD ON FIN CONDITION OF FINGERLING TROUT

By Louis E. Wolf
State Fish Hatchery, Rome, N. Y.

DURING THE SUMMER of 1937 Tunison and McCay ran an experiment to determine some of the changes that take place in the bodies of trout that grow slowly in contrast to those that grow normally. The details of this experiment have been published (see reference), but a brief resume of the procedure will be given here for the sake of those who have not seen the original report.

On April 16 a group of each of four species of trout fingerlings was started on a diet of fresh beef liver. This diet was continued for all the fish throughout the experiment. On July 9 each of the four groups was split into two lots, one lot being continued, as previously, on a "full" diet, i.e., about all the fish would eat; the other lot was given a "restricted" diet, i.e., the amount of food given was considerably less than the fish could eat, so that the fish did not grow as fast as those in the other lot.

The amount of retardation in growth of the "restricted" lots, as compared with the normal lots, can be seen from the following data, taken from the report of Tunison and McCay:

Average Weight of Trout in Grams

	April 16	July 9	Oct. 1	Oct. 1
			Normal Lot	Restricted Lot
Loch Leven	0.24	0.67	1.93	1.25
Lake	0.23	1.24	4.40	1.89
Rainbow	0.62	2.06	6.24	3.39
Brook	0.44	3.37	15.60	6.36

The last two columns show the stuning effect from limiting the amount of food in one lot after July 9.

On October 2 the writer was given the opportunity of examining the eight lots of experimental fish, and to make observations concerning their fin condition. This privilege was very kindly extended by Mr. Tunison as such observations were not within the scope of the study being made by him.

The notes made by the writer on the condition of the fins of these cots are given below. Only pectoral and dorsal fins were considered, but in only a very few cases were other fins diseased.

Species	Group	Fin Condition
Loch Leven	Well fed	DORSAL FINS all very good. PECTORAL FINS mostly good. Only a few diseased and ragged.
	Stunted	DORSAL FINS very good. PECTORAL FINS in terrible condition. Almost 100% diseased, in most cases so badly that the fins are mere stumps. An occasional fish has perfect fins, but such fish are always larger than the average for the group.
Lake	Well fed	DORSAL FINS perfect. PECTORAL FINS perfect.
	Stunted	DORSAL FINS perfect. PECTORAL FINS about 10% diseased. Rather mild in most cases.
Rainbow	Well fed	DORSAL FINS good, except for mild disease condition in occasional fish. PECTORAL FINS good, except as above.
	Stunted	DORSAL FINS mildly diseased in quite a few cases. PECTORAL FINS very bad. About 75% are missing, small and disintegrated, or at least partly damaged.
Brook	Well fed	DORSAL FINS very good. Occasional fin slightly thickened and white at outer edge. PECTORAL FINS all very good.
	Stunted	DORSAL FINS very bad. About 80% of fins are diseased, in most cases so badly that most of the fin is gone. No sores at base of fins. PECTORAL FINS bad, but not nearly as bad as the dorsals. About 20% are diseased, ranging from entirely gone, through badly disintegrated, to almost normal.

No study of the specimens was made to determine the exact nature of the disease which affected the fins, and the term "diseased" is here used to denote an abnormal, pathological condition, not necessarily a bacterial infection.

The data here presented are open to several interpretations. The first is that the fin condition was due to a quantitative nutritional deficiency. The good condition of the fins of the well fed groups indicates that the liver diet was, in itself qualitatively sufficient. The disintegration of the fins might be caused by a bacterial invasion which well-fed fish can resist, but which underfed fish cannot. The good fins of the stunted lake trout need not rule out this interpretation, since lake trout are commonly reported to be more immune than other trout to a variety of hatchery diseases.

Another interpretation, and this would perhaps appeal more to the practical fish culturist, is that the fin condition was due to "nipping", that is, hungry fish biting at the fins of their neighbors. The phenomenon of nipping has not been studied by the writer, and he must take the opinion of others regarding it. Though very little has ever been written on the subject all fish culturists known to the writer seem to agree that small fingerlings, held in troughs, nip each other's fins when hungry, and so start a process of fin disintegration which is perhaps aided by a secondary bacterial infection of the nipped areas. Fish culturists at Rome (N. Y.) are of the opinion that brook trout are the worst nippers of all, and that lake trout when hungry become cannibals rather than nippers. This last observation would again account for the healthy fins in the underfed lake trout.

But an objection to the nipping theory as a complete explanation of the fin condition found in these experiments could be raised on the basis of the findings on the stunted brook trout, whose dorsal fins were much worse than their pectorals. It is doubtful whether anyone would contend that dorsal fins are nipped to any great extent. Also, fish culturists consulted by the writer are of the opinion that nipping becomes common only in very small fingerlings, and that not much of it occurs as late in the season as July 9 - at which time the underfeeding of half of the fish began in the Tunison -McCay experiments.

We are certainly in need of some careful observations on the phenomenon of nipping. The writer is inclined toward the opinion that orthodox views on the subject are largely erroneous, and that nipping is very often a secondary, rather than a primary, cause of fin trouble. That is, fins already whitened and thickened, from whatever cause, attract the attention of neighboring fish and are nipped more often than healthy fins would be. And the primary whitening and thickening, and even disintegrating, is in certain cases due to malnutrition which weakens the resistance of the fish to bacterial invasion.

But, apart from any controversial theories, the lesson from this experiment seems to be that when fins go bad, and no parasites are found, the food allotment should be increased.

Reference

Tunison, A. V. and C. M. McCay, 1937.

The nutrition of trout. Cortland Hatchery Report No. 6, for the year 1937. New York State Conservation Department, Albany, N. Y.

WISCONSIN LAKES AND FISH INVESTIGATIONS

By Chancey Juday
Wisconsin Geological and Natural History Survey

THE LAKES and streams of Wisconsin are one of the most important natural resources of the State. This is due chiefly to the fact that the resort and tourist businesses now rank second in the big industries. These inland waters have an area of

some 1600 square miles and they furnish unexcelled facilities for recreation, such as fishing, boating, and bathing.

Angling is probably the major item in the recreation program; the number of anglers has been growing steadily in recent years and it will undoubtedly continue to grow in the future. Since the area of fishable waters is definitely limited, it will be necessary to keep the production of fish in these waters at a maximum level if reasonably good fishing is to be maintained for those who are interested in this sport. This can be accomplished by a liberal stocking of the waters and thus keeping the fish population up to the maximum carrying capacity of the lakes and streams; it is possible also that the carrying capacity can be increased by artificially fertilizing the water of some lakes, especially the smaller land locked lakes.

Food is the most important factor in determining the fish production of a body of water and any attempt to increase the carrying capacity of a lake or to bring it up to its maximum carrying capacity necessarily involves the food problem. Fundamentally such efforts must be based on the physics, the chemistry, and the biology of the water concerned, just as the physics, the chemistry, and the biology of the soil are involved in increasing the productivity of land. A poor water is not any more productive than a poor soil.

In an attempt to answer some of the questions concerned with productivity of lakes, the Wisconsin Geological and Natural History Survey began a systematic study of the lakes of the State in 1905. The U. S. Bureau of Fisheries has cooperated in the investigations since 1907 and in recent years the Wisconsin Conservation Department has taken an important part in them. During the past three years the Works Progress Administration has also cooperated in certain phases of the work.

These studies have dealt primarily with the amount and kinds of organic material produced by lakes which can be utilized either directly or indirectly for food by the fish population. They have shown that there is a wide range in the production of fish food by the various types of lakes. The difference in yield between some of the very soft water lakes of the northern part of the State and those with moderately hard waters in the southern part is as great as that between very poor and very rich land. In some cases the average standing crop of living material is as small as 900 pounds per acre in the former group, while it reaches as much as 7,500 pounds per acre in some of the southern lakes.

Not all of this organic material is directly available for fish food, however, because the major part of it consists of plants and most fish, especially game fish, are not vegetarians. The plant material must first be consumed by water fleas, insects and their larvae, snails and other animal life, and these forms in turn are eaten by the fish. This complicated food chain may have half a dozen links between the plants on the one hand and the fish on the other.

This problem brings up the question of the relation of this supply of potential food to the number of fish actually supported by a lake. Quantitative studies of the fish population and of the standing crop of food in one lake showed that the ratio

between them was one pound of fish to about 25 pounds of potential food material. On the basis of the amount of food acceptable to fish, such as water fleas, insect larvae worms, snails and other animals, the ratio was found to be one pound of fish to 5 pounds of food. Such studies are now being extended to other lakes.

For the past five years, experiments have been made to determine whether the microscopic life of a small landlocked, soft water lake can be increased materially by the use of farm fertilizers. Superphosphate, lime, nitrate and potash fertilizers have been employed, but best results were obtained with soybean meal. By applying 80 pounds of soybean meal to this lake during the summer of 1936, the standing crop of microscopic life in the lake was increased from an average of about 50 pounds of dry organic matter per acre previous to its use to substantially 85 pounds per acre during the season that it was applied; this represents an increase of 70%. Furthermore the soybean meal added in 1936 was still effective in 1937 because the average crop was almost as large in 1937, or 82 pounds per acre, and no fertilizers were added in the latter year.

The increase in the potential food supply in 1936 and 1937 seemed to increase the rate of growth of the fish. Some of the small mouthed black bass, that were hatched in 1936, for example, had reached a total length of a little more than nine inches on August 3, 1937, which would indicate that some of the 1936 brood probably attained a length of 10 inches before the end of the 1937 growing season. It was found also that the rate of growth of the perch was more than 20% above normal. This experiment seems to indicate that the rate of growth of fish can be speeded up to an appreciable extent by the use of fertilizers to increase the crop of microscopic plants and animals of a lake.

Growth of Game Fish

In order to get some idea of the rate of growth of game fish of the various waters of the State, anglers were requested to cooperate in such a study by sending scales and data regarding the length and weight of the fish they catch. This investigation has been in progress since 1928 and scales and records have been received from more than 5,000 fish during this time.

The age of a fish can be told by means of its scales. A full quota of scales is acquired by a young fish within three to six weeks after it hatches; in order to keep the body covered, these scales increase in size as the fish grows. The growth of both the body and the scales takes place chiefly or entirely in summer; the cessation or retardation of growth in winter is recorded on the scales in the form of a winter ring, similar to the growth rings found in trees. By counting the winter rings, therefore, the approximate age of the fish can be determined. A fish that has four winter rings on its scales, for example, has passed through four winters and is in its fifth year of life. A much larger number of specimens is needed for this investigation, at least ten times as many in fact. So it is hoped that the anglers who have been cooperating in the study will continue to do so and that many others will be willing to take part in the project. Scales from 50 to 100 specimens of each species of game fish in a lake will tell a very interesting and important story of the growth of the fish; it will also show which species is yielding best results.

Five reports have been issued on the rate of growth of the game fish included in the scale collection and they have been distributed to the anglers who have cooperated in the study. A copy of the fifth (1938) report will be sent to those who are interested in the problem and who are willing to cooperate by sending scales from the fish they catch.

These studies have shown that there is a marked difference in the rate of growth of game fish in different lakes. The muskies of one lake averaged ten inches longer at the end of the eighth year of life than those of another lake at the same age. Differences of two inches or more in the lengths of the large mouthed and small mouthed bass from different lakes were found in specimens that were six years old or older. Presumably these differences are due to differences in food supply, but this question remains for future investigation. These results are important from the standpoint of stocking the various waters with young fish. It is useless to place as many young fish per acre in a lake where the growth is poor as in one where it is very good. Likewise if bass show a better growth rate in a lake than wall-eyed pike, it will be more profitable to stock the lake with bass and plant the wall-eyes elsewhere. Of the two species of bass, the large mouth grows more rapidly than the small mouth up to about the sixth or seventh year, but their growth rates are substantially the same after this age is reached. The large mouth, therefore, gives more prompt returns in the early years of life.

The specimens now in the scale collection have made it possible to determine the average length for the various ages of fish and also the relation between length and weight. In the two species of black bass, the average increase in weight is about half a pound per year for those that weigh three pounds or more, but up to three pounds the annual gain in weight is smaller. The muskellunge, however, shows a larger average gain; a 30 pound muskie is usually from 14 to 16 years old, so that it shows an average gain of about two pounds per year. The annual gain of a northern pike or pickerel weighing ten pounds or more ranges from a pound to a pound and a half, and a wall-eyed pike gains a half to three quarters of a pound per year when it reaches a weight of three pounds or more.

The important assistance given by anglers in this study is greatly appreciated and their continued cooperation is greatly desired. Scale envelopes will be sent to anglers upon request; such requests should be addressed to the Wisconsin Conservation Department, State Capitol, or to the Wisconsin Geological and Natural History Survey, Science Hall, Madison, Wisconsin.

A VISIT TO PARADISE

By Cecil Heacox
State Fish Hatchery, Rome, N. Y.

(Editor's Note: Most of us are interested in the problems and methods of the commercial fish culturists, and probably most of our state and federal hatchery men know very little about these subjects. In the columns of the P.F.C. we have had few communications from the commercial group, although we number many of them among our

readers. Much as we would like to hear from them we find that they, in common with all fish culturists, hate to take time off from their work to set their ideas down on paper and thus we have a large source of information lying untouched. We have often wished we had at our services a roving reporter who could spend his time visiting commercial hatcheries and send us exhaustive reports on the methods in use at each. But it is unlikely that we shall ever be able to number such an individual on our staff. We do have among our contributors, however, a number of persons who may be persuaded to visit some of the private hatcheries in their vicinity and send us brief accounts of their observations. This would result in a series of articles which would be of increasing value as it progressed for each writer would have all of the preceding series available as a background for his own efforts. The following article starts the ball rolling. It is by no means intended as a detailed and complete account of the methods in use at the Paradise Brook Trout Company, but we think that our readers will find the article interesting in spite of its brevity.)

IT WAS RECENTLY the privilege of the writer to be assigned the detail of acting as messenger for a consignment of brook trout eggs from the Paradise Brook Trout Company, Cresco, Pennsylvania to the New York State Hatchery at Rome.

We suppose that all fish culturists have wished that they could take a year off and visit the various fish cultural stations about the country, or at least spare enough time from their work to exchange ideas and opinions on hatchery operating technique with their colleagues at other plants. Therefore, we warmly welcomed our good fortune at being able to have a look in at one of the country's largest and most famous private commercial hatcheries, and although the subject deserves a more technically informed pen than that of a mere apprentice in the profession still in the tenderfoot stage, we feel that the information we casually picked up may interest readers of this journal.

A hatchery which must pay its own way in order to continue to exist, without subsidy from the state or sportsmen, is certainly worthy of the hatcheryman's attention.

Mr. George Stack, superintendent in charge of operations, was more than considerate of the novice in his charge and managed until the very end to retain his natural good humor.

"It's the same old story that you always hear," he laughed, "what works in one hatchery might be disastrous in another."

"But surely there must be some basic points in operating procedure which you have found to be successful," we suggested, adding hastily, "and make the company continue to pay dividends."

"Well," hedged Mr. Stack, "I can tell some of the things which work for us under our conditions. For instance, we find that we get satisfactory results by only cleaning our ponds once a year. Naturally this might not work out successfully in some hatcheries. We use the old-fashioned wood rack type of outlet screen and carry a

sufficient number of fish in our ponds to keep the sediment stirred up pretty well. The current of the water carries it away making the ponds practically self-cleaning. Doubt if you could do it with the conventional wire screen which is used at many hatcheries.

"You will notice that there are no fancy fixin's around here. We have to concentrate on production, not looks. We expect to sell in the neighborhood of 15,000,000 eggs this season. Each year we hatch about 425,000 fish in our own plant. From these we replenish the brood stock and sell the remainder. At spawning time we try to have about 25,000 three-year old breeders on hand for stripping. We also strip many of our two-year old fish. Fish for restocking purposes - to sportsmen's clubs and the like - will amount to about 60% of our fish annually. About 40% are sold for table use each year. Pennsylvania, New York, and New Jersey take most of these."

We watched an attendant net out a scapful of yearlings, alive with health and vigor. We marveled at their brilliant colors.

"Paradise brook trout have always been noted for their beauty," we remarked. "Do you put something in the food which brings out these pronounced green mottlings and vivid red spots?"

"It's not so much the food but rather proper feeding," he replied. "The quality of the water is very important. Our springs will have an average flow of perhaps 800 gallons per minute. Summer temperature at the source runs around 50° F. and at the end ponds may go as high as 72° F."

"How about feeding?" we ventured timidly.

"I was afraid of that," he answered wryly. "After all, though, it's a pretty simple thing with us. Feeding charts are swell but we just haven't got around to them yet. All of our men are old timers at the game. Fish culture is just a form of animal husbandry. Our men know their animals, so to speak. We are very careful not to feed too much and that is another reason the ponds require so little cleaning. We start our fry on finely ground sheep's liver. When the fingerlings are about five months old we begin to feed some sheep's plucks. At the age of six months, some fish is also added. At the time they become yearlings we feed 50% sheep's plucks and 50% fish. We don't mix the meat and the fish but feed straight on alternate days. In preparing the meat, we use extreme care cutting out all fat and gristle. We have found salt water herring to give us the best results. Personally, I think the salt water fish make a better diet than the fresh water varieties. That's about all there is to it."

We looked at our watch. It was almost time to take the egg cases to the train and a hundred questions were popping in our head.

"We've taken up a lot of your time," we began, apologetically.

"Hell," he interrupted, "there's a difference between taking up time and encroaching on eternity!"

Exit from Paradise!

COMMENTS FROM OUR READERS

REACTIONS TO MR. YOUNG'S CHALLENGE, "WHERE DO WE GO FROM HERE?"

(Editor's Note: You can't strike sparks from soapstone. There is indication that steel has struck flint in the sparks from three of our readers presented herewith.)

Editor, THE PROGRESSIVE FISH CULTURIST:

The article, "Where Do We Go From Here", by Ralph W. Young in the May, 1938 issue of the PROGRESSIVE FISH CULTURIST is obviously offered with the best of intentions but I wish to take exception to some of the statements which he makes in the section entitled "Scientist versus Hatcheryman".

In the first place I object to the heading, "Scientist versus Hatcheryman", which no less an authority than Noah Webster would translate more simply as "Scientist against Hatcheryman". It seems obvious from the text that Mr. Young means what he says. Now I haven't been around fish hatcheries 30 years, in fact 30 years ago I was learning to ride a tricycle, but I have been around long enough to learn that the first and cardinal principle of successful fish culture is complete cooperation between scientist and hatcheryman.

Secondly, I guess we don't have average hatcherymen in New Hampshire. I've been spending the past week treating a rather virulent outbreak of gill disease among 200,000 brown trout fry at one of our hatcheries. The superintendent is nearly seventy years old and has raised fish all his life. The rest of the staff are old timers, too. Of course, they may be contemptuous and amused because I have shown them how to treat and protect a million fry in about three hours. Perhaps they have been laughing behind my back while the daily loss dropped from 15,000 on Wednesday to 8,000 on Thursday, then to 6,000, 3,200, 1,400, 1,200 and finally 800 today. Where would they have been without me? Gill disease in fry doesn't give a hatcheryman time to fiddle around trying salt, copper sulphate, or some other "30 year old" remedy. On the other hand, where would I be without the hatcheryman? If I live to be a hundred I'll never get to know fish like the men who work with them, live with them, and sometimes go without sleep for them.

There may be conceited, arrogant pseudo-scientists who attempt to hide ignorance with big words and look upon hatcherymen with contempt. It sound as though Mr. Young has had personal experience with such a person but while I haven't seen 20 hatcheries I have seen 20 scientists and not many would fit the above characterization. Any man who fails to appreciate a hatchery's practical problems and disregards the experience of hatcherymen just ain't no scientist, no matter how he draws his pay check, if any.

On points 3 and 4, I wish to disagree with Mr. Young in part. I am delighted to demonstrate my microscopic, cultural, or other findings to all hatcherymen. I'd be glad to stand on my head if it would stimulate further interest in the control of disease. But I'm not kidding myself or the hatcherymen into believing that the parasitological information which they get from me is going to work me out of a job. I doubt that Mr. Young would care to turn his hatchery over to an amateur fish culturist. Well, I wouldn't want to turn my work over to an amateur parasitologist. If you can't learn to be a fish culturist out of a book, is it not reasonable to suppose that the same might hold for parasitology? Parasitology calls for special training, background, study, and experience just as does fish culture. After eleven years of trying to be a parasitologist I know I'm never going to have time in this life to become a fish culturist also and unless hatcheries are run differently in the rest of the country than they are here I don't think many fish culturists are going to have enough time on their hands to take parasitology very seriously.

And as for point 5, Mr. Young's chin is truly "way out"--I'll try furunculosis, in fact I'll be glad to send him a slide made from a formalin preserved fish that should settle the argument.

And lastly, I beg the editors to save this letter from the waste basket. If they don't care to have it clutter up the CULTURIST please send it to Mr. Young. I'd like to help the old cuss raise fish and show him microscopic slides after hours.

Frank H. Connell,
Dartmouth College,
Hanover, N. H.

Editor, THE PROGRESSIVE FISH CULTURIST:

Appropos of Mr. Ralph W. Young's "WHERE DO WE GO FROM HERE" in the May, 1938 issue of the P.F.C., he should review a few of the pleas we older fish culturists have made for many years past regarding concerted action towards improving the strains of brood stock in trout. The Transactions of the American Fisheries Society are filled with such references, and the results of such experiments. THE PROGRESSIVE FISH CULTURIST itself contains two articles that will bear rereading -- "IMPROVEMENT OF TROUT BROOD STOCK THROUGH SELECTIVE BREEDING" by Dr. H. S. Davis, in the December, 1935 issue, and another by the writer in December, 1936, "SELECTING AND DEVELOPING A BROOD STOCK OF TROUT".

Much of the lack of progress in improvement of methods and equipment in fish culture today is due to the fact that the younger generation of fishery workers are not conversant with what has taken place in the past. Hundreds of suggestions that are proposed as original today, have been tried out many years ago and abandoned as impractical.

It was with a great deal of regret that I learned of the loss of Dr. Needham's experimental supply of brood stock and eggs of Salmo nelsoni. However, this not as disheartening as would have been the case had these fish been carried through several generations of domesticated stock. I sincerely hope that a new supply may be obtained and the experiment continued.

In relation to these experiments of developing a non-migratory type of rainbow trout, it is suggested that eggs from some of the rainbows permanently resident in interior desert reservoirs be tried out for this purpose. While Fish Commissioner of Idaho I had many opportunities of observing the disinclination of such fish to migrate, even though the environment in which they were found was distinctly unfavorable. Many of these comparatively small reservoirs are filled to overflowing during the spring run-off, and it would be the logical thing to suppose that any downstream migration would occur while a great volume of water was pouring over the spillway. Seldom, if ever, were any great numbers of either large or small rainbows found in the stream channel below such dams after the overflow ceased. The depth of water in many of these artificial lakes seldom exceeded 15 or 20 feet when the basin is filled and often is drawn down during the irrigating season to not more than 6 feet in depth and with a surface temperature of well up towards 90 degrees.

That such bodies of water would produce and maintain rainbow trout of a rapidly growing type and in good condition is almost unbelievable. To cite an instance, the Roseworth Reservoir some 50 miles southwest of Twin Falls, Idaho was drawn down about every third year to a mere puddle, but for several seasons we collected upwards of a half million excellent rainbow eggs from this source. I know the condition of these spawning fish, for I helped strip them on a number of occasions myself, and the eggs produced vigorous, rapidly growing fry and fingerlings. There are any number of similar reservoirs throughout that country that should provide either brood stock or eggs for experimentation.

William M. Keil,
U. S. Forest Service,
Asheville, N. C.

Editor, THE PROGRESSIVE FISH CULTURIST:

It is encouraging to read the article by Ralph W. Young in the May issue of the P.F.C. since it shows an increasing appreciation on the part of fish culturists that all is not well with their vocation. However, in view of Mr. Young's disparaging remarks I would like to say a few words in behalf of the much maligned "bug hunter." The assumption of Mr. Young and other fish culturists that most of their disease troubles would be over if they could only be provided with a microscope is understandable. No doubt a microscope would be a great help and I have recommended for years that every hatchery have one but I am not so foolish as to believe that this would solve most of our difficulties.

There are a few common parasites that can be easily recognized under a microscope but nothing could be farther from the truth than the not uncommon belief that a few minutes instruction in the use of the microscope would enable fish culturists to recognize most diseases. Even the most common parasites can be confused with somewhat similar organisms by an inexperienced observer and I recall one instance where a "most destructive parasite" turned out to be a fish scale. Moreover, to diagnose many diseases requires not only a microscope but a knowledge of fish anatomy and pathology.

Another common fallacy is the idea advanced by Mr. Young that if fish culturists could only be provided with mounted specimens of fish parasites they would be able to recognize them when they appeared on their fish. The difficulty with this is that it is impossible to preserve protozoa and other small fish parasites so that they retain a life-like appearance. As a matter of fact when mounted by standard methods they may have only a very slight resemblance to the living animal. A much better conception of the natural appearance can usually be gained from a good drawing than from a preserved specimen.

Finally, I would like to disagree with Mr. Young in his contention that it is impossible to diagnose diseases in fish from preserved specimens. He is perfectly correct in his assertion that it is usually impossible to identify preserved bacteria from their appearance but the same is true of living bacteria. In most instances bacteria differ so little in appearance from other related forms that it is impossible to differentiate between species on this basis alone. There are, of course, a few exceptions and while I have no ulterior designs on Mr. Young's much abused chin it happens that the bacteria causing gill disease can be easily identified in preserved specimens.

Mr. Young overlooks the fact that certain bacteria produce specific effects on the host which can be recognized by an experienced pathologist. In most cases these characteristic lesions are the distinguishing marks that he looks for, not the causative bacteria. In the case of parasitic protozoa or worms the parasites can usually be identified if the fish are properly preserved.

However, it must be admitted that the diagnosis of disease from preserved specimens alone has its limitations and is reliable only in the case of well-known diseases characterized by distinctive lesions or caused by parasites that can be easily recognized. Right here it should be emphasized that a correct diagnosis depends in no small degree on the man who submits the specimens. Frequently he fails to give pertinent information which is always a great aid in diagnosing any disease. This, however, could be overlooked if he would only make more effort to preserve specimens suitable for diagnosis. Fish that have evidently been dead for hours before being preserved are often sent in, although they are usually useless for diagnostic purposes. Many parasites leave the fish shortly after death and degenerative changes set in very quickly, so that an accurate diagnosis may be impossible.

But what especially stirs the ire of the long-suffering pathologist is the guy - and he is all too common - who, upon observing a few dead fish in a trough, grabs a net, makes a swipe and drops a few specimens in formalin without taking the trouble to determine whether they are sick or not and then cusses the pathologist because he is unable to tell him what is wrong (if anything) with the fish.

H. S. Davis
U. S. Bureau of Fisheries
Washington, D. C.

AGAIN, FISH SORTERS

Editor, THE PROGRESSIVE FISH CULTURIST:

The perennial question of fish sorters has again been raised by Mr. K. E. Morton in the February-March number of THE PROGRESSIVE FISH CULTURIST. Mr. Morton's suggested sorter is of the self-working or automatic type, which recalls some experiments I performed several years ago along these lines.

My idea was to sort fish in a trough by crowding them into the lower half, then setting a grating in the middle and letting the smaller ones work upstream through the grating into the upper half. Thus, two size-groups would automatically separate themselves through the natural tendency of the fish to move against the current. This is also the principle involved in Mr. Morton's suggestion.

The grating I used consisted of prcperly spaced brass rods fixed to a wooden framework. This grating could also be fastened to the bottom of a box and used in the manner of an ordinary sorter, that is. by sifting the fish down through.

I crowded the fish into the lower end of the trough, wedged my grating in place, and went on about my business. Thirty minutes later I returned and was much disappointed to find that only a very small proportion of the smaller fish had availed themselves of the opportunity to get ahead in life by wriggling through into the uncrowded upper half of the trough.

Since the stimulus of the current was apparently not adequate I contributed an additional inducement by covering the upper half of the trough leaving the lower half exposed to the bright sunlight. This, I thcught, would surely cause an upward migration. But, thirty minutes later the results were still most unsatisfactory. It, therefcre, became obvious that sterner measures must be emplcyed and employed they were.

On the theory that loud and abusive language might be repugnant to such a high-strung creature as a trout I stationed myself at the lower end of the trough and hurled derogatory epithets at the fish accompanying this with wild waving of a white cloth and threatening lunges in their direction. Such behavior on my part did cause

considerable activity among the trout and also succeeded in luring several small boys from the neighborhood to the scene of the experiment. They proved highly cooperative and were put to work beating on pans, jumping up and down, and otherwise conducting themselves with enthusiastic impropriety.

These devices succeeded in freightening many of the trout through the grating into the covered upper end of the trough, but since we were all having such a good time we were loath to desist until the last small fish had been chased up to where it belonged. After about five minutes, however, it was noticed that some of the subjects in the upper half of the trough were coming back down into the lower part again, apparently for the purpose of obtaining a better view of the proceedings. Thereupon we terminated our efforts, quickly placed a screen against the grating so that no more of the small fish could slip back with the larger ones, and surveyed our handiwork.

In order to see how thorough the sorting had been 100 fish from each group were measured. Their standard length was recorded in centimeters. These lengths, after being grouped, were made into the two graphs shown in Fig. 1. This figure will be discussed later.

All the fish were then mixed together again and sorted once more, but in the conventional manner. For this second sorting the same grating was used, but it was attached to the under slide of a bottomless box and the fish sifted down through it one netful at a time. The thoroughness of this sorting was then determined, as in the previous case, by measuring a random sample of 100 fish from each group. The two graphs obtained from these data are shown in Fig. 2.

It will be seen that in both figures the curves overlap, that is, the sorting was not 100 percent efficient in separating the two size-groups. In Fig. 2, for instance, the two curves begin to overlap at 7.7 cm., and continue so up to 10.2 cm. This means that all fish 7.7 cm. long, or smaller, were forced through the sorter so that they got in with the small group. No fish 10.2 cm. long, or larger, succeeded in slipping through. Between these limits the sorting was varyingly efficient. The two curves cross at the 9.4 cm. mark, which means that half the fish this size got through the grating and half did not. In other words, there was no selective action whatever for fish this size and the sorter was zero percent efficient at this point.

By referring from each size class within the region of overlap of the two curves in Fig. 2 (shaded area) to the number column on the left, we can count the number of fish from each of the two groups which fall within this area. In Fig. 2 this will be found to be 30 fish from each group. Since each group consisted of 100 individuals we can say that the sorting was 30 percent inefficient, or better, 70 percent efficient.

Inspection of Fig. 1 will show that there are 47 individuals in the region of inefficiency. The sorting, in this case, was therefore 47 percent inefficient, or 53 percent efficient. Fig. 1 also shows that the inefficiency of the "automatic" sorting was not derived so much from the large fish crowding through the sorter as from the small fish refusing to be driven toward the head of the trough.

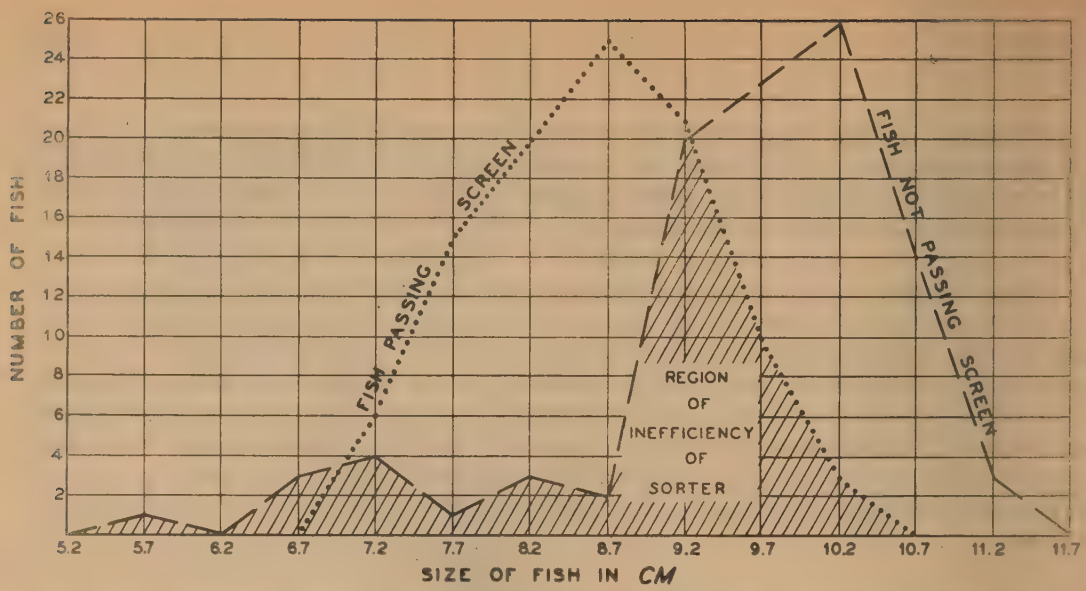

FIG. 1. AUTOMATIC SORTER

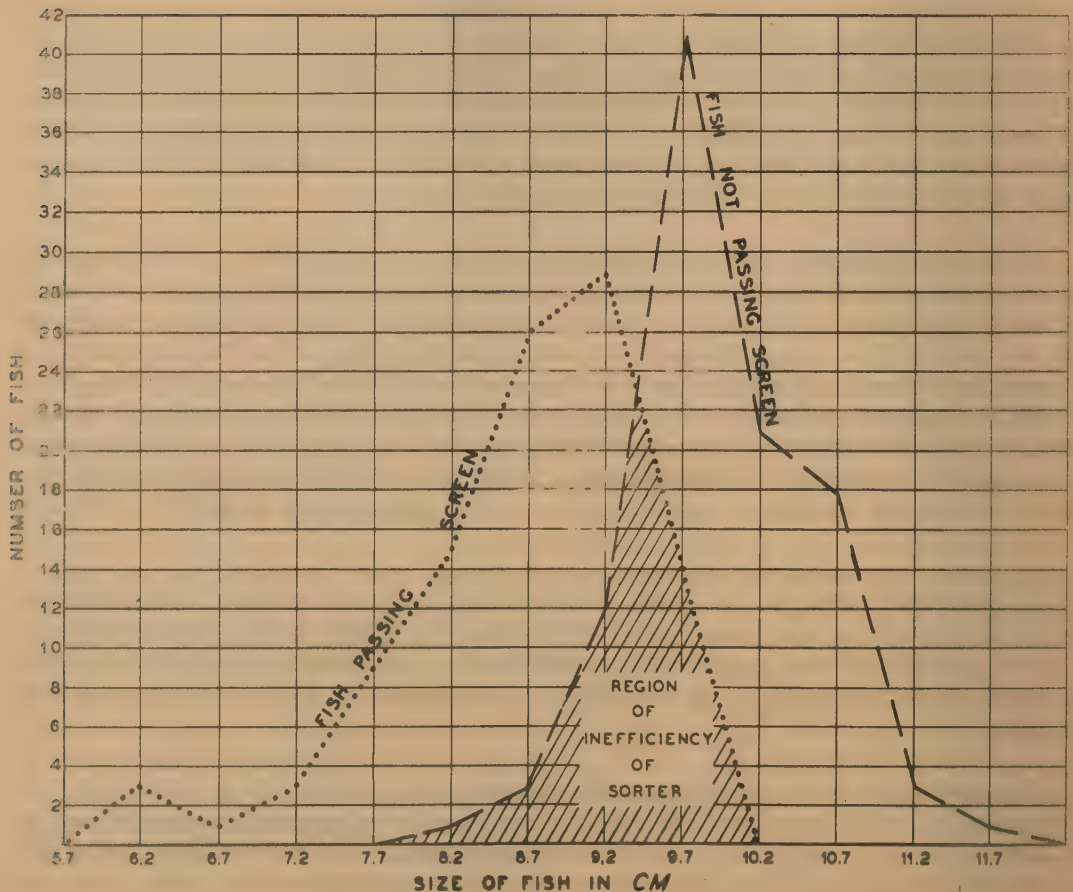

FIG. 2. BOX SORTER

Since the results of this experiment gave an efficiency of 70 percent for the box sorter, as compared with 53 percent for the "automatic" sorter, I am inclined to doubt the feasibility of automatic devices. Fish, at least trout, do not seem to have an overwhelming desire to travel upstream.

Louis E. Wolf,
State Fish Hatchery,
Rome, N. Y.

NOTES AND NEWS

SECOND ANNUAL MEETING OF NORTHEASTERN FISH CULTURISTS

FISH CULTURAL problems of the New York and New England area were discussed at the second annual meeting of Northeastern Fish Culturists held at Burlington, Vermont, March 25 and 26. The Burlirgton meeting was the second of its kind, the first such get-together of fish culturists and other conservationists of the region having been held at Ithaca, N. Y., last year.

During the three sessions held on the first day of the meeting, 14 papers were presented and motion pictures of stream surveys in New York and fish cultural operations in Vermont were shown. Three additional papers were given during the Saturday morning session. Problems of fish management in Lake Champlain held the center of the stage both days. The meetings were well attended, drawing representatives of the conservation departments of the New England States and New York, members of the scientific staff of the U. S. Bureau of Fisheries, practical fish culturists, zoologists from various universities of the region, and several Canadian conservation officials.

Discussing possibilities of improving fish yields on Lake Champlain, Dr. J. R. Greeley, ichthyologist of the New York Conservation Department, pointed out although a good start has been made toward coordinated effort on the part of New York, Vermont, and Quebec, much remains to be done to perfect an efficient, well-coordinated management program for the valuable recreational fisheries of Lake Champlain. As a first step, a continuous program of study was urged to provide an up-to-date record of lake conditions. In order to maintain the favorable environmental conditions that now exist in the lake, pollution should be controlled and march areas which serve as spawning and rearing grounds for certain species must be protected from destruction by alteration of the water level. A favorable population balance, it was pointed out, is often dependent upon the functioning of an adequate number of large predatory fish. In Lake Champlain, although some large fish annually escape the anglers, the numerous yellow perch constitute a potential threat to the balance of other species. Increase in the size-limit of smallmouth bass and well-eyed pike and protection of pickerel or northern pike were recommended as aids to building up the large fish populations of the lake.

Interesting facts and figures on the species distribution of anglers' catches in the Vermont waters of Lake Champlain were presented by the director of the Vermont Fish and Game Service, R. P. Hunter. During the 15-month period from August, 1936 to February, 1938, 2,270 anglers were interviewed by wardens. Reports from these anglers may be divided into 3 groups according to the method of fishing: ice fishing, 67.66 percent; shooting, 1.19 percent; angling, 31.15 percent. In the 15 months covered, 24 percent of the fishermen were unsuccessful. Of the successful fishermen, 42 percent reported yellow perch in their catch and 34 percent reported smelt. Smallmouthed bass were taken by 3.8 percent of the anglers. The species percentage of the total monthly catch stands at 47.59 percent for perch and 47.31 percent for smelt. The remaining 5.10 percent was distributed as follows: common sunfish .86 percent; bluebacks .71 percent; small-mouth bass .54 percent; rock bass .65 percent; wall-eyed pike .58 percent. The average catch per fishing attempt was 12.9 fish, of which 5.66 were perch, 6.58 were smelt, and .71 were any of the other species mentioned.

Stocking will probably be of little value in building up the smelt populations of Lake Champlain, C. Willard Greene, biologist of the New York Conservation Department told the fish culturists at Burlington. The larger, more desirable race is not available for stocking; the smaller race appears to maintain itself adequately and its further increase might interfere with the food supply of the larger. Dr. Greene does not believe that effective size limits could be enforced. Instead, he recommended restrictions on season length and on sale of the catch for the management of the species in Lake Champlain. Knowledge of the fact and extent of depletion is needed before regulation is attempted, he pointed out. In a study of scales taken from spawning runs of smelt at 4 Vermont lakes, Dr. Greene found that the smelt native to three of the lakes spawn only once; those from the fourth lake probably twice. Age at maturity varied from 2 to 3 years. From a comparison of the life span, age at maturity, number of spawning years, and approximate maximum size of eight freshwater smelt populations and one salt water population, he tentatively concluded that the life span of the fresh water smelt is somewhat less than that of saltwater forms and that in inland lakes reduction of spawning years to the minimum of one year may occur with relative frequency.

An experimental study of the effect of rapid growth of hatchery trout on stream trout quality was reported on by A. V. Tunison, C. M. McCay, A. M. Phillips, and E. O. Rodgers of the Cortland, N. Y. experimental hatchery. Growth rates of various organs in 4 species of trout were compared during the fingerling stage to discover whether the organs share equally in the growth of the body when that growth is unduly accelerated. Part of the experimental trout were retarded in growth and part made to grow as rapidly as possible. It was found that the eyes in all species studied tend to continue growth when that of the entire body is retarded. The possibility of using eye weights or possible the size of the eye as an additional condition factor to evaluate the nutritional state of trout in streams under natural conditions was suggested. Organs such as the heart, liver, and gastro-intestinal tract were found to represent about the same percent of the entire body weight whether the trout has been retarded in growth or not. Chemical analyses showed that trout develop in the same way as other animals - the moisture content decreasing and the protein, fat, and ash contents

increasing with growth. Retarding of growth results in less of fat and protein with an increase in ash content.

The trend toward holding larger numbers of fish for distribution as legal size trout was indicated in the report of fish production in New York State hatcheries presented by Charles R. Deuel and A. V. Tunison of the New York Conservation Department. At the end of the past December the state hatcheries had on hand about one and a quarter million trout as compared to 600,000 in December, 1936 and 400,000 in December, 1935. During the year ending in December, 1937, roughly 6,150,000 trout had been distributed in the state as compared to 5,900,000 in 1935 and 5,640,000 in 1936. The weight of these fish was about 100,000 pounds in 1937, 66,000 pounds in 1936, and 73,000 in 1935, indicating that the average trout distributed in 1937 was about 3½ inches long while those distributed in 1935 and 1936 were about 3 inches long.

Other papers presented at the meeting were as follows:

An Epidemic of Ichthyopthirasis at Rome, N. Y., by Louis E. Wolf, New York Conservation Department.

Development of Low-cost Fish Diets, by A. H. Dinsmore, in charge, St. Johnsbury, Vt. and York Pond Hatcheries, Berlin, N. H.

Bass for Stocking Depleted Waters, by O. R. Kingsbury, New York Conservation Department.

The Wall-eyed Pike, Lake Champlain, by John Van Oosten, in charge, Great Lakes Fisheries Investigations, U. S. Bureau of Fisheries.

Yellow Perch of Lake Champlain, R. H. McGonigle, Atlantic Biological Station, St. Andrews, New Brunswick, Canada.

A Biological Investigation of Lake Champlain, by Prof. H. F. Perkins, University of Vermont.

Results of Vermont's Test Water Program, by R. F. Lord, U. S. Bureau of Fisheries.

Preliminary Evaluation of Experiments in Stream Improvement in Connecticut by G. W. Hunter, III, Wesleyan University, and Lyle Thorpe, Connecticut Board of Fisheries and Game.

Determination of the Food Grade of Streams, by C. McC. Mottley, Cornell University.

Pond Fish Management Program in Connecticut, by Lyle M. Thorpe, Connecticut Board of Fisheries and Game.

Seasonal Changes in Invertebrate Bottom Fauna of Trout Streams, by W. H. Behney, University of Vermont.

New Hampshire Stream Survey, by Earl E. Hoover, New Hampshire Fish and Game Department.

ANNUAL MEETING OF THE PACIFIC FISHERY BIOLOGISTS

THE PACIFIC FISHERY Biologists, an organization of investigators engaged in studies of fishery problems on the Pacific Coast, held its second annual meeting on March 24-26, 1938 at Lummi Island in northern Puget Sound. The purpose of this organization, which was established in 1936, is to provide more frequent contact for the ready exchange of ideas and mutual criticism among its members. Because of the free and informal nature of the discussions the minutes of its meetings are not published, but through the courtesy of the retiring secretary-treasurer, Dr. A. L. Pritchard, and by permission of the past presidents, Dr. R. E. Foerster and Dr. R. Van Cleve and the new president, Dr. J. L. Hart, an opportunity to review the minutes has been provided and a digest of their contents is presented herewith.

Following the first luncheon of the organization on March 24, the retiring president, Dr. Richard Van Cleve, presided over a brief business session and then proceeded to a consideration of the subject, "Predators, the Measure of their Effect and Methods of Control." Dr. W. A. Clemens presented a discussion on "Birds as Predators of Fish," reviewing chiefly the Canadian investigations on this subject. General conclusions from the work of H. C. White on the northeast Margaree river on the Atlantic Coast indicate that kingfishers and mergansers, although feeding upon what was available in the stream, were nevertheless at certain times a definite threat to the salmon population. The views of Dr. A. G. Huntsman were mentioned regarding his extensive work on the relationship of the 9.6 years periodicity of salmon abundance and times of drought, during which period mergansers and kingfishers take their toll of young salmon in fresh water. In reviewing his own work with J. A. Munro, Dr. Clemens stressed the fact that birds have an economic and esthetic value and that their extermination is out of the question. The problem of predation is a very complicated one, involving the inter-relations among animals, fundamental ecological relationships and problems in population, and it requires a strictly scientific approach for its solution. Predation is increased by land clearance, which results in low water where birds find it easier to obtain prey. Also, the epidemic of stream clearing has resulted in a decrease in natural protection. Dr. Clemens believes that a positive policy, increasing production by improving environmental conditions, would be reasonable. The solution of many of the population problems lies in this line of endeavor and not in the destruction of any on predator.

A. C. DeLacy spoke briefly on the program of predator control through the destruction of Dolly Varden "trout" in Alaska. Large numbers of these chars have been destroyed at a considerable annual cost. Little is known of their life history or of the size of their populations in different localities.

Predators of fish in California were discussed by Leo Shapovalov, who referred particularly to fish predators in the experimental project at Waddell Creek where the total number of fish migrating up and down stream has been determined for several years. Sculpins of two species were found to be present in considerable numbers, but because of their inability to pass upstream their abundance has declined remarkably since 1933. Stomachs from the larger species of Cottus revealed a considerable number of eggs and young of trout and salmon. Probably most of the eggs were washed out of

the spawning beds. Mr. Shapovalov also made the comment that a serious danger lay in making a great issue of predators in general, thus diverting attention from other causes of depletion of game and commercial fishes such as the diversion of water, deforestation, and overfishing, which would cause depletion even if no predators existed or if all were eliminated.

In discussing predator control at Cultus Lake, B. C., Dr. R. E. Foerster reviewed the work of the past several years in this locality, the efficiency of natural propagation in the lake and efforts to determine the part played by predator fishes, squawfish, chars, and trout, largely, in contributing to the 94 percent mortality of sockeye salmon fry in the lake. The campaign of predator fish destruction removed 10,000 large squawfish, 500 chars, and 900 trout in 1935 and 1936. The effect of such removal was expected to be indicated by the extent of seaward migration of sockeye from the lake in the spring of 1937. At that time 3,100,000 yearlings were counted. These resulted from an estimated egg deposition of 40,000,000, thus providing a percentage efficiency of 7.75 which was approximately 4.4 times the average percentage obtained prior to the reduction of predators.

Dr. W. E. Ricker in discussing the effects of predator control gave consideration to a number of theoretical factors drawing analogies from terrestrial forms. He came to the conclusion that results of predator control at Cultus Lake show that (1) the removal of predators has resulted in a much greater percentage of survival of fry during the year they are in the lake, (2) the average size of yearlings (for migrations of the same size) has greatly increased, presumably because more food is available per fish, and (3) there is no evidence of increased intraspecific predation.

Lloyd A. Royal discussed the human race as predators, pointing out that mortalities caused by the industrialization of the waters, diversion of water for irrigation and power, and fishing for salmon along the streams are extremely high and are correlated with the size of the population in that particular area. The effect of predation by natural enemies is small in comparison with the mortalities resulting from the causes listed above and may be ignored, he contended.

During the second day, March 25, the session was devoted to a discussion of the place of plankton investigations in practical fisheries research. The topics discussed under this section were: "The Place of Marine Plankton Work in Practical Fisheries Research," by Dr. Van Cleve; "The Role of Plankton Investigations in Practical Fisheries Research," by Dr. Ricker; "Qualitative Plankton Investigations in British Columbia," by Dr. G. C. Carl; "Plankton Investigations of State of Washington Game Department," by R. C. Meigs.

The evening session presented something of a novelty at fishery conferences, being devoted to a discussion of "Gadgets New Equipment Which Has Been Found Useful in Fisheries Work." Among the devices described and demonstrated were a tagging gun for the insertion of internal tags in herrings and pilchards, electromagnets for the recovery of tags, a magnetic detector for the recovery of individual fish, a model fish counting weir, a depth gauge, a stream sampler, a clam marking machine, methods

for determining oxygen requirements, a pulpit for biological work, a method of cleaning fish ponds, rotating stands for holding pails and other apparatus in hatcheries, and methods of measuring lengths of small fish without injury.

The Saturday morning, March 26, session was devoted to a consideration of methods now in use on the Pacific Coast for collecting statistical data on the fisheries, accuracy and utilization of the data collected, and the possibility of coordination and improvement.

Because of its general interest in the field of aquiculture the report of the standing Committee on Productivity, appointed the previous year, is presented in full herewith by permission of the organization. This committee consisted of Dr. W A. Clemens, Dr. W. E. Ricker, and J. T. Barnaby.

PRODUCTION IN BODIES OF WATER

THE SUBJECT of production is of particular interest to fishery biologists and it has seemed advisable to define certain terms and to outline some of the factors affecting production.

While the material presented applies to all bodies of water, reference is made only to lakes as a matter of convenience.

Production and Productivity Are two words are best used synonymously. They are so thoroughly confused in popular usage that an attempt to assign them different and exact meanings would be more or less useless.

I. TERMS AND THEIR DEFINITIONS

A. Gross Production and Net Production

The gross production of a lake is the total amount produced of organisms or organic materials per unit of time. More particularly, it is the increase in weight of all such materials during such time, up to the point where they change their form. Thus, if the gross production of fish during a year be under consideration, it includes all increase in weight of any fish living in the lake, at any time during the year, regardless of whether they survive to its end or not. Or again, if the lake's yearly gross production of protein be under consideration, it would be the total quantity of proteins of all kinds elaborated during the year, regardless of whether these were subsequently digested or oxidized during the same year; the same actual materials (phosphorous, carbon, etc.) might in fact appear several times in adding up the total of protein produced.

The net production of a lake per unit of time may be defined as the excess of elaboration over destruction (or more generally, of gain over loss) of specified organisms or organic materials during the time in question. In the examples above, it would be the difference between the total weight of living fish at the beginning and at the end of the year; or the difference between the total amount of protein at the same times. It is easy to see that the concept of net production is much more susceptible to quantitative evaluation than is that of gross production. To estimate net production for a given period, it is necessary only to measure the standing crop at the beginning and the end of the period, and take the difference. It follows that net production so measured must often be negative, and in such case would be called net decrease, whereas gross production, as defined, can fall to zero but cannot ever be negative.

Net production is most useful when the time under consideration is short For example, the net vernal production (increase) of phytoplankton can be measured, and may be a large quantity. There may be a net increase in a certain species of fish over a period of years, as recently with the yellow pickerel of Lake Huron, or of sockeye in Cultus Lake. But in general, as the time interval is increased, the net productions, both negative and positive, for both single species and groups of species or materials, tend to be stabilized at some small negative or positive value. This value will be governed only by the magnitude of current physiographic and climatic changes in the lake's physical nature and environment. Exception to this statement must be made, however, in the case of the introduction, whether by natural or artificial means, of new species into the lake.

It is important not to confuse the concept of net production with that of utilized production, to be described later. Fish, etc., destroyed by predators, including man, will affect the net production in so far as they affect the standing crop at the end of the period under discussion; but "net" production as here defined does not suggest utilization of the product, but rather its accumulation.

B. Total Production and Specific Production

Total productivity of a lake refers to its total production of organic matter of all kinds per unit of time. Total net production of organic materials, considered over periods longer than a year, must usually be close to zero; must be, in fact, the slow accumulation of organic matter associated with changes in the "trophic" or food character of the lake, as in increasing eutrophy or dystrophy.

The specific productivity of a lake is its production of certain specified kind of organisms or organic materials. Such materials may be chosen on any conceivable basis; e.g. chemical; carbohydrates, amino-acids, etc.; or phylogenetic: plants, animals, bacteria, insects, fish, etc.; or according to their situation in the lake: plankton, benthos, etc.; or according to their usefulness to man: game fish, coarse fish, big fish, etc.

C. Actual Production and Potential Production

Actual production refers to conditions as they are now. Potential production is a useful concept to indicate the probable effect of proposed changes, and should be used in conjunction with a clause indicating the nature of such changes, e.g., "this lake has a potential production of 1000 lbs. of bass per year if the pike were to be destroyed;" or "Lake Erie has a potential (utilized) productivity of five times as many ciscoes as at present, were its fisheries to be properly regulated." A great variety of changes may be proposed or anticipated: adding news species of plants or animals, removing others already present, improving spawning beds for fish, warming the water by deforestation of the shores, changing the volume of flow, etc. There is, however an upper indefinite limit to permissible changes, as for example, if the lake were dammed to double its area, it would in effect be a new lake. Potential productivity, like the actual, may be thought of as gross or net, total or specific, but in practice the term is usually confined to the sense of specific utilizable production.

D. Utilized Production

1. Actual utilized production may be defined as that part of a lake's organic products which is used by man.

2. Possible utilized production may be defined as that part of a lake's organic product which may be used by man without endangering future supplies (i.e., causing depletion). When the actual utilized production exceeds the possible utilized production depletion is taking place.

3. Potential utilized production may be defined as that part of a lake's organic product which might be used by man, without endangering future supplies, providing certain changes were made in the environment, whereby production is increased. Potential utilized production is a useful concept to indicate the probable effect of proposed changes, and should be used in conjunction with a clause indicating the nature of such changes, e.g., "this lake has a potential utilized production of 1000 pounds of bass per year if the pike were to be destroyed."

Definitions in Brief

The actual organic production of a lake may be subsumed under the following heads:

	Total Production	Specific Production
Gross production	Total elaboration of organic materials, plus organic stuffs from other sources.	All increases in weight (or numbers) of a species; or total new additions to the stock of an organic substance.

	Total Production	Specific Production
Net production	Excess (or defect) of organic income over loss; which is a measure of the change in a lake's trophic character, over long periods.	Increase or decrease in abundance of a species, or in its total weight. Same for given classes of organic stuffs.
Utilized production	-	The "catch" of a species of fish; the amount taken of any other utilized organic object.

II. METHODS OF DETERMINING THE PRODUCTION OF LAKES

A. Utilized Production

1. The actual utilized production can be determined by keeping "catch" records. This is fairly easy in the case where a commercial fishery is prosecuted but is frequently difficult in the case of a sport fishery.

2. The possible utilized production is difficult to determine accurately, however, a study of it is essential to the intelligent regulation of a fishery. If the catch, or take, is constant for a period of time and evidence is at hand to indicate that depletion is not taking place, then the possible utilized production may be fairly close to the actual utilized production. This does not necessarily follow for if the fishery is not intensively prosecuted the actual utilized production may be considerably below the possible utilized production. However, a fishery which has much value is usually actively prosecuted and the population is either being depleted or is in danger of depletion. If depletion is just beginning to occur some information on the size of the possible utilized production may be ascertained from the data. If depletion has taken place it is obvious that the actual utilized production has exceeded the possible utilized production and conservation measures must be inaugurated to save the resource. To determine the possible utilized production the catch and the standing crop, or population, at fairly short intervals of time must be known. The standing crop has been determined sometimes by (1) poisoning and then collecting all dead fish or by (2) draining the lake and then collecting the fish. Either of these methods have the disadvantage of bringing to an end the prevailing relationships and can only be used in small lakes in any event. The standing crop can in some cases (plankton) be determined by quantitative sampling. However, this method is not very satisfactory for most species due to the difficulty of obtaining representative samples. The determination of the standing crop has been attempted by marking a number of species, releasing them, later recapturing them and from the data on number marked and percentage occurrence of marked individuals in the catches, the number of individuals in the population can

be calculated. While theoretically the method is valuable difficulty is usually experienced due to differential mortality of marked and unmarked fish, loss of tags if the fish are marked by tagging, and difficulty of collecting representative samples of the population. A relative measure of the population can sometimes be obtained by a statistical study of the catch per unit of gear.

A knowledge of the standing crop does not, in itself, furnish any information on the productivity of a lake except that in general the larger the standing crop the greater the productivity is apt to be. If the standing crop is the same at the end of an interval of time (the interval being one or more cycles) as it was at the beginning (net production being zero) the possible utilized production is equal to the actual utilized production.

3. The potential production of a lake is always a hypothetical figure as it is difficult, or impossible, to evaluate accurately the effect of changes in the environmental character of a lake. This concept of productivity is, however, of great importance as in addition to maintaining a fishery the aim of fishery management should be, if possible, to increase the possible utilized production.

III. FACTORS AFFECTING THE PRODUCTIVITY OF LAKES

A. Physical Properties

1. In general, the size, shape, and depth of the lake affect the size of the populations of the various species therein. These factors to some extent control the temperature of the water, shallow lakes being warmer in summer and colder in winter (other factors being constant) than deep lakes and hence have an effect on the type and growth of the population.

2. The nature of the surrounding country affects the biotic condition of a lake in many ways, abundance of terrestrial organisms, the amount of sunlight, and the run-off into the lake.

3. The turbidity of the water which is controlled by numerous factors directly affects the amount of photosynthesis and the character of the flora and fauna.

4. The flow of water through the lake is important from a variety of standpoints such as temperature, effect on the thermocline, introduction and removal of chemicals, and effect on turbidity.

5. The latitude and elevation of a lake affects its temperature and the nature of the surrounding flora.

B. Climatic Conditions

1. The temperature controls the character of the population and its growth rate.

2. The amount of precipitation is important from a number of viewpoints, in a measure it determines the inflow, outflow, and level of the lake, and has a pronounced effect on the surrounding flora.

3. The amount of light is of importance in controlling photosynthesis and is itself affected by latitude, weather conditions, vegetation in the lake, and the nature of the surrounding country.

4. The amount of wind is frequently important in affecting the temperature, depth of the thermocline, and exchange of gases between the air and the water.

C. Chemical Properties

1. The chemical properties of a lake are naturally important as they are really the building stones on which all life is dependent. There are certain chemicals found in lakes which are not used for growth and their presence is unimportant. However, the concentration of chemicals in a lake may be such as to inhibit the growth of certain organisms. A given concentration of chemicals may be harmful for some organisms and may be beneficial to others hence we have a variation in the flora and faune of lakes in accordance with the variation in concentration of the various chemicals. It is usually the case that any chemicals added to a lake in relatively large amounts are injurious even though small amounts may be harmless. In this respect the pollution of streams and lakes by sewage, industrial wastes, salt water from oil wells, etc., needs careful consideration. Sometimes a small amount of pollutant may be beneficial, but the usual picture is to find the chemical composition of the stream or lake being radically changed with resultant changes in the flora and fauna.

2. The total chemical composition of a lake is constantly changing due to various causes. Chemicals are added to lakes by the inflow of streams, by pollution, by the wind (02), by terrestrial insects dying or being eaten by fish, and by anadramous fish. Chemicals are lost from lakes by outflowing streams, catch of fish, migrations of fish, predatory birds, etc.

D. Density of Population of Utilized Species

1. The effect of the density of the population of a utilized species is, of course, of vital importance in determining the productivity of a lake of that particular species. Obviously if a species is not present in a lake, its production of that species can only be zero regardless of its capacity to produce. The ease of accessibility of a lake to anadromous fishes may

affect its production of those species. To get the greatest possible production of a given species the density of the population of that species must be kept at an optimum value. Keeping the population of the species at a figure above or below the optimum value can only result in a smaller possible utilized production. The determination of this optimum value and keeping the population at that value is one of the most important functions of the fishery administrator.

E. Abundance and Kinds of Other Flora and Fauna in a Lake.

1. The utilized species are (except in the case of plants) dependent on other forms of life for their food and all factors affecting the food supply indirectly affect the lake's production of the utilized species.

2. Disease producing organisms may play an important role although their effect under strictly natural conditions is thought to be slight.

3. Predators are, of course, important in that they are in a measure in competition with man in reaping the crop and consequently a reduction in the toll taken by the predators usually results in an increased utilized production. As is the case when any changes in the environment are made by man extreme caution should be exercised to determine the full effects of removing predators as the predators may, in part, be controlling some other undesirable species.

4. Population pressure caused by extreme abundance of some other species may have an effect on the production of the utilized species though such cases are rare.

5. The area and condition of the spawning grounds may be influenced by the kind and abundance of the flora.

IV. AIMS OF FISHERIES MANAGEMENT

A. The "catch" or "take" should be regulated so that the actual utilized production is neither less than, nor greater than, the possible utilized production. If the actual utilized production is less than the possible utilized production the yield of the lake is only being partially exploited. If the actual utilized production is greater than the possible utilized production depletion is taking place.

B. The possible utilized production should, if possible, be made to equal to the potential utilized production. This can be attempted in a number of ways, among the most common of which are, to bring the density of the population of the utilized species to its optimum value by proper regulation of amount and kind of fishing, control or extermination of predators, control of undesirable species which are competitors for food with the desirable ones, control of diseases, improving spawning beds, introducing new species, indirectly increasing the food supply by the addition of chemicals, etc. Considerable care needs to be taken in any steps to increase

the possible utilized production in that it is usually extremely difficult to determine beforehand the full effects of some proposed change before the change is made. For example, a new species may be introduced which in itself may be valuable but which may have a very deleterious effect on some other still more valuable species already resident in the lake. Again some species which may prey on some valuable species may be killed off without taking into consideration the possible value of that species in controlling a third species which may be a predator or competitor for food with the first one. The introduction of new species may and frequently does result in the introduction of disease producing organisms which are sometimes very destructive.

C. The catch or take should be regulated so as to produce the greatest possible economic benefit. This is one phase of fisheries management that has not always received as much attention as it should. If there is one season of a year when a species is in poor condition the "take" during that season should be curtailed or prohibited so that the "take" at some other season may be increased. Thus without a material increase in the quantity of the "take" its value might be materially raised. Regulation of the use to which a fishery product is put may be important and in some cases this has been done. Each individual case requires separate consideration and hard and fast rules cannot be laid down as to the best methods for controlling a fishery so as to produce the greatest good, however, this aspect of the situation should always be considered in formulating fishery regulations.

NOTICE TO CONTRIBUTORS

OCCASIONALLY in the past authors of longer articles appearing in THE PROGRESSIVE FISH CULTURIST have requested reprints or additional copies of the number for personal distribution and have been disappointed to find that the supply is exhausted soon after the date of issue.

We cannot supply reprints of separate articles, but owing to the economical method of production, we shall be glad to provide a limited quantity of an entire number to authors who state their needs when manuscripts are submitted.

REVIEWS

SOME RESULTS OF TROUT TAGGING IN MASSACHUSETTS

By Robert A. Nesbit and J. Arthur Kitson

Copeia No. 3, November 19, 1937.

ABSTRACT

TO DETERMINE whether it is more advantageous to plant trout in the autumn or to hold them in rearing ponds until the following spring, several thousand rainbow and brown trout were tagged and released in two lots in Massachusetts rivers and ponds, one lot in the fall, the other the following spring, as indicated in Table I.

Internal tags of bright yellow, soft rubber 1 1/4 inches long by 1/4 inch wide and about 1/32 inch in thickness were used. The method is not recommended for future experiments of this type, inasmuch as the chrome yellow pigment proved toxic enough to cause considerable mortality during the first two weeks after tagging, and many of the tags were lost through the body wall at a point about opposite the original incision. However, since all the fish were tagged in the same manner at the same time losses traceable to the defects in the tagging method may be disregarded for purposes of comparison. For the spring planting, percentages of fish recaptured (as indicated in Table I) are based on the numbers of fish released and known to be bearing tags when released, less the percentage loss observed to occur during the winter among the tagged fish held for spring planting.

In no experiment was the percentage recaptured from fall - planted fish as high as from spring-planted fish. The differences were less marked in the two ponds than in the rivers, where the differences for rainbow trout averaged about 5 to 1. Therefore, a given number of spring-planted fish may be expected to yield a catch 5 times as large as the same number of fall-planted fish.

The additional cost of holding fish in the hatchery over the winter and the possible improvement in gaminess and quality of fish planted in the fall should be weighed against the advantages indicated above. The additional cost of carrying trout of the sizes used in the experiment from December 1 to April 1 is estimated at approximately 2.5 cents per fish, an increase of about 50 percent in the cost. But since the number of surviving fish is so much augmented the cost per fish caught by sportsmen is actually materially reduced. As the present experiment throws no light on the comparative flavor and color of spring and fall-planted fish, it would be of interest in future experiments to determine whether anglers are able to distinguish between the two.

TABLE 1. TROUT TAGGED AND RECAPTURED IN THE 1934-35 EXPERIMENTS OF THE MASSACHUSETTS DIVISION OF FISHERIES AND GAME.

Experiment	Tagged Number	Losses		Released Number	Released Number Adjusted	Recaptured Number	Recaptured %	Ratio of % Spring to % Fall Recaptures
		Died	Tags Lost					
Rainbow trout:								
Millers River. Spring planting	918	90	176	652	652	97	14.9)	9.9 to 1
Millers River. Fall planting	978	59	6	913	645	10	1.5)	
Onota Lake. Spring planting	494	81	129	284	284	26	9.2)	2.1 to 1
Onota Lake. Fall planting	497	32	1	464	328	14	4.3)	
Brown trout:								
Westfield River. Spring planting	937	225	113	599	599	70	11.7)	5.1 to 1
Westfield River. Fall planting	933	253	4	676	554	13	2.3)	
Farmington River. Spring planting	985	253	127	605	605	55	9.1)	2.9 to 1
Farmington River. Fall planting	985	266	..	719	589	18	3.1)	
Big Spectacle Pond. Spring planting	491	143	32	316	316	7	2.2)	2.0 to 1
Big Spectacle Pond. Fall planting	499	173	..	326	267	3	1.1)	
Rainbow and Brown trout:								
Rivers. Spring planting	2,840	568	416	1,856	1,856	222	12.0)	5.2 to 1
Rivers. Fall planting	2,896	578	10	2,308	1,788	41	2.3)	
Ponds. Spring planting	985	224	161	600	600	33	5.5)	1.9 to 1
Ponds. Fall planting	996	205	1	790	595	17	2.9)	

Spring planting not only gives anglers more fish for a given cost but gives them larger fish, since fish held over the winter in the hatchery grew faster than those planted in streams in autumn. The size-superiority of spring-planted fish was found to be about one inch.

Inasmuch as conditions affecting over-winter mortality differ greatly in different streams, similar experiments should be performed to determine the best policy for each set of conditions encountered.

R.L.C.

SELENIUM POISONING IN FISHES (*)

By M. M. Ellis, H. L. Motley, M. D. Ellis, and R. O. Jones. Proceedings of the Society for Experimental Biology and Medicine, 1937, 36, 519-522.

ABSTRACT

OBSERVATIONS ON goldfish kept in glass jars to which known quantities of sodium selenite were added showed that selenium could be taken up in cumulatively lethal quantities by fish from the surrounding water. On the 8th day of exposure to 2 parts per million of selenium, the fish began to refuse food and this loss of appetite, which always marked the beginning of the fatal phase of selenium poisoning, continued for several days. Thereafter the fish showed lack of coordination in their movements and disturbance of equilibrium. As poisoning progressed the fish became more lethargic and feeble. Death followed after 18 to 46 days of exposure. In other tests in which 5 parts of selenium per million were introduced into the jars, goldfish died in from 4 to 10 days, the symptoms of poisoning being the same as in the first series.

In other experiments in which known quantities of selenium were injected into the body cavities of 550 catfish, both acute and delayed reactions were obtained. The toxicity of the selenium increased with temperature. Fish dying from acute poisoning showed contraction of the chromatophores in the skin and were thus definitely lighter a color several hours before death than control fish. The symptoms of incoordination and spasmodic movements were also apparent. Fish receiving doses not immediately toxic developed a marked "popeye" condition and enlargement of the abdomen 7 days after the injection. These conditions grew progressively worse and the fish died about 20 to 25 days after receiving the injection.

R.L.C.

---

* Note: The work on selenium is particularly significant in view of recent surveys which show this element, naturally present in some water and soils, to be a widespread menace to fish in several western states.

FISH PREDATION INVESTIGATION

By Karl F. Lagler, In Charge Fish Predator Investigations for the University of Michigan and the American Wildlife Institute. American Wildlife, vol. 28, no. 6, November-December, 1937 pp. 86-87 and 92.

ABSTRACT

ATTEMPTS TO control predation have often had undesirable and unexpected results. Development of effective control measures depends upon comprehension of the total problem of fish predation, which can be acquired only through a wide variety of natural history information. Analysis of stomach contents must be supplemented by knowledge of actual feeding habits, the condition of the food when taken, whether living or dead, the availability of each food species and the proportion of its population consumed.

A cooperative investigation undertaken by the University of Michigan and the American Wildlife Institute is being devoted to studying the nature and extent of vertebrate predation on fish, evaluating the effects of this predation, learning which species are retarding the production of more and larger game fishes and how, and discovering methods of controlling serious depredations by fish-eating animals without killing them. Although the field work is being carried on in Michigan, it is believed that the results will be applicable in detail to other northern states and in general to the whole country. Species with which the investigation is chiefly concerned are: Local representatives of the heron family, kingfisher, gulls, terms, American merganser, common water and garter snakes, snapping turtle, Blanding's turtle, soft-shell turtle, musk turtle, common painted turtle, otter, and mink.

Two major categories of predation are being investigated. One is the condition created at hatcheries and rearing stations where fish-eating animals are more or less literally baited by the high and unprotected concentrations of fishes. The other is predation in wild or natural waters. It is believed that all habitats frequented by a predator need to be considered in order to obtain a complete picture.

Although it has been customary to kill the fish-eating or supposedly fish-eating animals which have been attracted to the hatcheries and rearing stations, it is believed that vertebrate predators have been blamed for an unfair proportion of the usual unaccountable hatchery losses. Less obvious causes of death such as disease, malnutrition, cannibalism, harmful temperature and chemical conditions in the water, mortality from careless handling, and other indirect factors are also important.

To acquire sound facts and interpretations on which to base effective predator control, stomachs and intestines from animals killed in control of predators about hatcheries and rearing stations in Michigan have been preserved for some years and analysis of this material is being supplemented by studies of the intensity, fluctuations, and seasonal variations in predation pressure at various hatcheries. Limited field and experimental observations have also been made.

Experiments are being conducted to find out how readily the destruction of hatchery fish may be prevented by means other than the killing of predators. Habitats have been selected for study to determine the role of bank and overhead shrub cover in excluding predaceous birds, conversely to learn how much the vulnerability of fish to bird predators is increased through clearing out of this cover or through flooding. Possible effects of different types of stream improvement in affording additional protection for fish or in creating habitats favorable for the predators will also be investigated, as will the extent to which fishing by man prevents predation, especially from fish-eating birds.

Regarding the category of predation which occurs in the wild, it is concluded (from returns on tagging and creel oensuses) that man is the most effective predator, followed by predaceous fishes, including such sport fishes as trout and bass.

As a result of this investigation, it is expected that a clearer concept of the status of the various predator species will arise, the pressure of control will be removed from animals unjustly regarded as predators, and tested methods of control will be available for use in reducing the usual large annual toll by predatory species

R.L.C.

FARMING DANISH TROUT FOR EXPORT

By C. V. Otterstrom. Danish Foreign Office Journal, No. 203, December, 1937, pp. 135-139, Copenhagen.

ABSTRACT

ALTHOUGH THERE are some commercial establishments in the United States where anglers may catch trout at so much per pound, trout farming as a method of supplying a market for table fish has had little or no development. However, interesting possibilities in this direction are suggested from the data presented by Dr. Otterstrom in his recent article on trout farming in Denmark.

There are today in that small country approximately one hundred trout farms. The first ponds were started about 1890 but the industry underwent its first real development early in the present century. Trout farming was given a severe set-back by the loss of the German market during the World War, but subsequently the development of new markets has permitted a steady increase in exports in spite of tariff barriers and quota restrictions.

The importance of the Danish export trade in artificially reared trout is well illustrated by the following tabulation of the annual shipments from the country over the period, 1931-1936.

Year	Export (pounds)
1936	1,613,178
1935	1,540,634
1934	1,462,797
1933	1,367,762
1932	1,207,899
1931	1,122,786
Average	1,385,843

England provides the leading market for Danish trout. Other important markets are found in Belgium and Luxemburg, France, and Switzerland. A formerly excellent Italian market collapsed with the involvement of that country in the Ethiopian war. The German and Austrian markets are also practically closed at the present time. The first shipments to the United States were made in 1935 when 3500 pounds were imported. This quantity was increased to 6600 pounds in 1936.

In 1935 and 1936, thirteen and fifteen percent respectively of the exportations consisted of live fish. The heaviest sales of live trout are made in Belgium, Luxemburg and Switzerland.

Exportations of trout eggs are also large. Over the period, 1930-1936, the annual shipments average 68 million eggs.

Danish trout farms concentrate on rainbow, brown, and brook trout. The rainbow is the most common of the three although the brown trout is also popular. The brook trout is not now reared as extensively as in former years. The rainbow enjoys the advantage of very rapid growth but the brown trout frequently brings a better price.

The trout are fed almost exclusively on chopped sea-fish which can be delivered in a fresh condition from nearby ports. Other foods, such as lungs from slaughter houses, are used to a very limited extent.

Formerly, trout were almost always sold as "portion trout" with a weight of 4½-6 ounces, but today many are marketed at a weight of 12-14 ounces, or when slightly less than a foot long. The sales of breeders after several years' service provides also a certain quantity of larger fish weighing more than two pounds.

The small home market for trout has been stimulated in recent years by the sale of large dressed fish. Male trout are purchased by laboratories which use the milt in the manufacture of insulin and then place the fish on the market.

In an effort to expand the industry further experiments have been made with smoked trout and canned products, including trout caviar.

Ralph Hile.